Chemical Engineering

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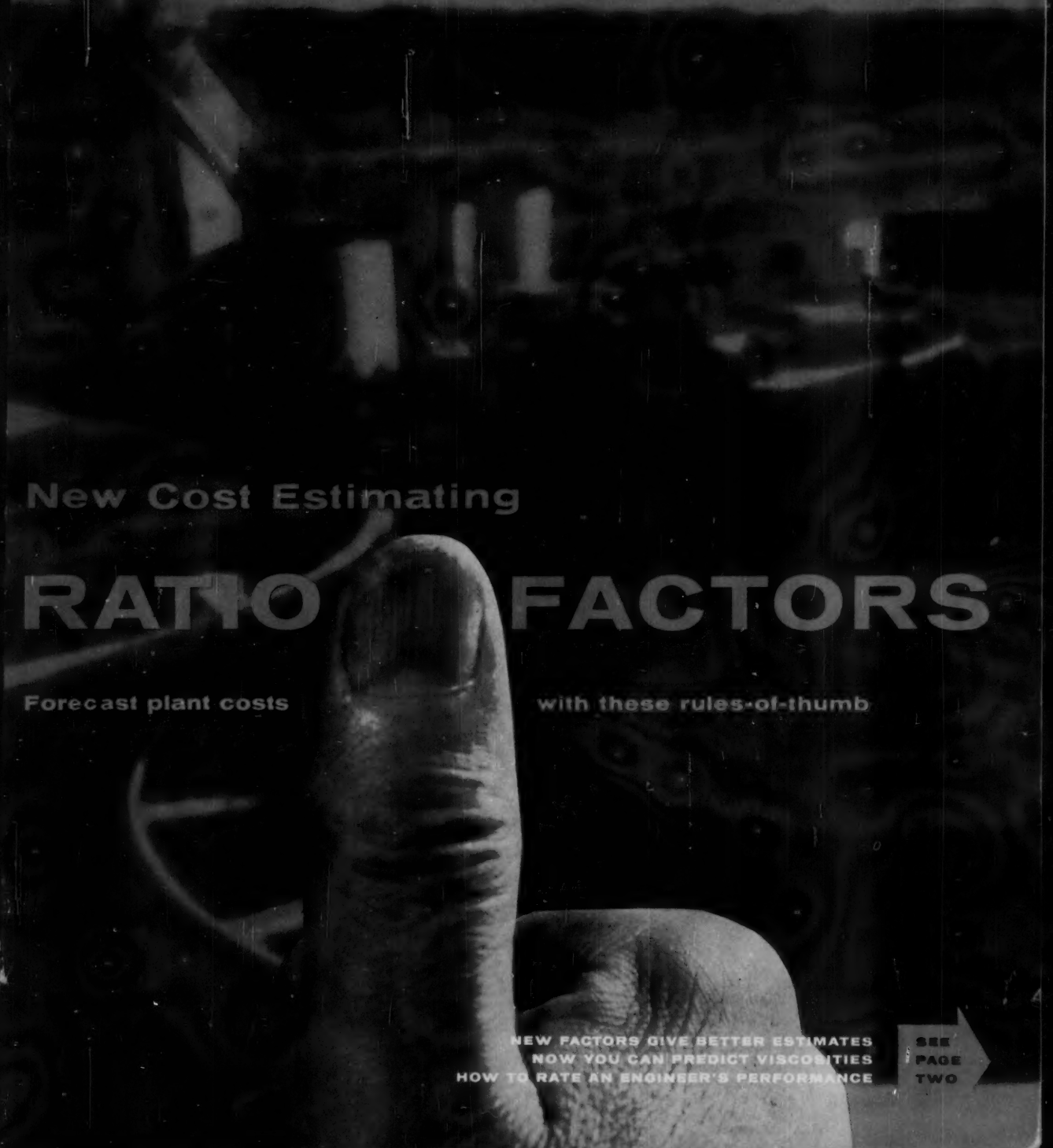

New Cost Estimating

RATIO FACTORS

Forecast plant costs with these rules-of-thumb

NEW FACTORS GIVE BETTER ESTIMATES

NOW YOU CAN PREDICT VISCOSITIES

HOW TO RATE AN ENGINEER'S PERFORMANCE

SEE PAGE TWO

Votator®

HEAT TRANSFER APPARATUS

Rapid cooling gives heat-sensitive resin added life

New outdoor installation of VOTATOR Continuous Cooler at Bakelite Company, a Division of Union Carbide Corporation, Bound Brook, N. J.

At Bakelite Company, another Votator* Cooling Unit has recently been installed to increase output of their quality phenolic resins. The original equipment has been in constant use since 1946. In this application, function of Votator Processing Apparatus is to prolong product life by rapidly cooling the resin prior to filling into drums, tank cars or storage tanks. As temperature drops, viscosity increases to more than 4000 cps. Output is 5,000 to 10,000 lbs. an hour.

Find out how you can improve *your* product and cut costs with Votator Heat Transfer Apparatus for continuous cooling, controling heat of reaction, emulsifying, crystallizing and sulfonation. Write for further information.

GIRDLER PROCESS EQUIPMENT DIVISION

CHEMETRON CORPORATION

Louisville 7, Kentucky

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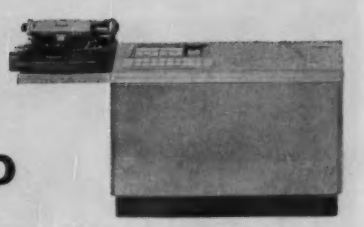
Sales Offices: Louisville • New York • Chicago

CHEMETRON

*VOTATOR—T.M.Reg. U.S. Pat. Off.

TODAY'S GREATEST VALUE IN ELECTRONIC COMPUTERS!

ROYAL PRECISION LGP-30



Compare it, feature by feature, with the other computers in its class

Feature	Computer A	Computer B	Computer C	Computer D	LGP-30	
Memory Size	220 words for data only	2160 words	1000 or 2000 words	84 words for data only	4096 words for data & program (either or both)	LARGEST CAPACITY IN ITS CLASS
Max. Speed Add Multiply	 20/sec. 4/sec.	 Comparable to LGP-30	 Comparable to LGP-30	 3/sec. 1/sec.	 Over 440/sec. Over 50/sec.	SPEED EQUAL TO MANY ROOM-SIZED COMPUTERS
Size	17 sq. ft.	6.5 sq. ft. plus table for typewriter.	45 sq. ft.	9.2 sq. ft. plus table for typewriter & control unit.	11 sq. ft.	COMPACT, DESK-SIZED, COMPLETELY MOBILE
Input-Output	Keyboard only — tape at extra cost.	Independent tape preparation at extra cost.	Extra cost peripheral equipment required.	Tape and typewriter for numerical input-output only. Independent tape preparation at extra cost.	Tape typewriter for alpha-numeric input-output standard equipment.	DELIVERED COMPLETE. NO ADDITIONAL EQUIPMENT NEEDED TO PREPARE DATA, PROGRAM OR REPORTS
No. of tubes	165	450	2,000	248	113	FEWER COMPONENTS MEAN LESS MAINTENANCE, FEWER CHECKOUTS
Voltage	220 V	110 V	220 V	110 V	110V	PLUGS INTO ANY REGULAR WALL OUTLET
Power	2.5 KW	3.0 KW	17.7 KW	1.65 KW	1.5 KW	NO SPECIAL WIRING OR AIR-CONDITIONING REQUIRED
Ease of programming & operation	Not alpha-numeric. No internal program storage.	Alpha-numeric at extra cost. 8 part instruction. Requires computer specialist.	Alpha-numeric at extra cost. Requires computer specialist.	Not alpha-numeric. No internal program storage.	Alpha-numeric. Complete internal program storage. Standard typewriter keyboard. Simplest command structure of all.	EASY TO PROGRAM AND OPERATE.
Cost Sale Rental	 $38,000 $1000/mo.	 $49,500 $1485/mo.	 $205,900 $3750/mo. up	 $55,000 $1150/mo.	 $49,500 $1100/mo.	LOWEST COST EVER FOR A COMPLETE GENERAL PURPOSE COMPUTER

Nation-wide sales and service. Trained staff of applications analysts. Library of subroutines available, plus programs for wide variety of applications.

For further information and specifications on Royal Precision LGP-30, call your nearby Royal McBee office, or write Royal McBee Corporation, Data Processing Division, Port Chester, N. Y.

ROYAL McBEE

WORLD'S LARGEST MANUFACTURER OF TYPEWRITERS AND MAKERS OF DATA PROCESSING EQUIPMENT

Chemical

SEPTEMBER 22, 1958

NINETEENTH OF TWENTY-SIX ISSUES

19/26

Estimate Plant Cost More Accurately

How's your luck on preliminary estimates of capital costs? Erratic? Here's a way to fatten your "performance average." Monsanto's senior cost estimator, Norman Bach, shows you how to modify ratio estimating so that you can convert equipment costs to a more accurate estimate of completed plant cost. (p. 155)

What's Life Span of Graphite Exchanger?

Even though corrosive liquor holds no terror for impervious graphite heat exchanger, descaling operations may limit its life. Union Carbide's experience with reboilers gives us a yardstick for life expectancy and maintenance costs. (p. 184)

Revolution Shapes Up in Pipe Welding

Now used for welding public utility pipe runs, new ultra-high-frequency welder completes weld within 1½ min. (p. 96)

Silicones No Longer Vulnerable to Oil

Fabulous silicones now boast even greater versatility. Now, nitrile groups in organic part of molecule give resistance to oil and solvents without loss of silicones' unique stability at extreme temperatures. (p. 92)

Developments in Chemical Engineering

CHEMENTATOR

From Geneva: Uranium Shortcuts 67
Henkel Terephthalic Wins First Job 69
Rosin Maker Finds Pellet Answer 69
Fluid Bed Updates Ancient Desulfurizer 69
Steel-Mill Wastes Nourish Ammonia Plant 72
Waste Sludge Blunts Effluent Toxicity 72

PROCESSES & TECHNOLOGY

Army Permits Peek at Nerve Gas Facilities 74
Moving Beds Double Ion Exchange Capacity ... 80

CHEMICAL ECONOMICS

What's Happening to Linear Polyethylene? 86

CHEMICAL PRODUCTS

7 Newsworthy Chemicals and Raw Materials ... 92

PROCESS EQUIPMENT

Mobile Induction Welder Spurs Field Piping .. 96
More News of Equipment 98

Practice of Chemical Engineering

PROCESS FLOWSHEET

Preheating Cement Kiln Feed Saves Btu.'s 146

FEATURE ARTICLES

More Accurate Plant Cost Estimates 155
Norman G. Bach

Speed Pressure Drop Calculations 160
Ning Hsing Chen

How Environment Directs Corrosion Control .. 163
Robert V. Jelinek

Estimate Low-Pressure-Drop Calculations 169
Wallace R. Gambill

Engineering

Vol. 65, No. 19

YOU AND YOUR JOB

How to Measure Individual Performance 173
Robert G. Trout

DESIGN NOTEBOOK

Here's Your Wallet-Size Slide Rule 175
E. C. Pirie

Kill Static in Lab Screening 176
Merton Allen

New Data Supplement Liquid Viscosity Chart .. 176
Jerome A. Seiner

OPERATION & MAINTENANCE

Ordering Mechanical Seals 178
Harold Bartz

CORROSION FORUM

How Much Life in Graphite Heat Exchangers? .. 184
C. P. Dillon

Other Regular Features

Petrochemicals & Petroleum Refining Index 5
Firms in the News 191
Convention Calendar 200
More New Equipment Developments 202
Technical Bookshelf 216
Classified Section 239
Equipment Searchlight 239

Reader Service

Guide to Technical Literature 220
Reader Service Postcard 229
Reprints Now Available 231
Advertisers in This Issue 245

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CE is edited for the engineers who develop, design, build, operate, maintain and manage chemical operations of all types. More engineers subscribe to CE than to any other magazine in the field. Print order of this issue:

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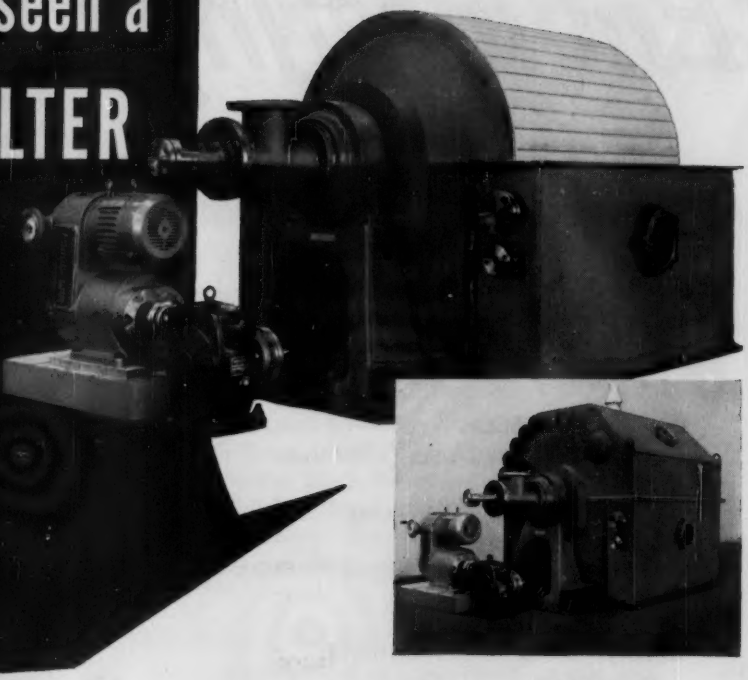
You've never seen a VACUUM FILTER like this when it comes to...



HIGH CAPACITY — the Bird-Young Filter has as much as six times the capacity per foot of filter area as the ordinary, multi-cell, drum filter. It handles slow filtering solids in thin cakes at high speeds to achieve extraordinarily high output. It handles fast filtering solids at high rates because filtrate flow is unrestricted.

DRY CAKES — due to extremely effective employment of vacuum over almost the entire drum surface.

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FUME-TIGHT OPERATION — the Bird-Young Filter can be made positively fume or vapor tight and can operate in a closed system.

You've never seen a vacuum filter like it. Its design is different. Its construction is different. Its performance may give you an entirely new conception of vacuum filtration efficiency and economy.

Why not find out what it can do for you. The Bird Research and Development Center is equipped to provide prompt and dependable test findings.

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Chemical Engineering

This issue's top features in ...

Petrochemicals & Petroleum Refining

SEPT. 22, 1958

Also of Basic Interest

Chementator 67
Processes & Technology
Nerve Gas Facilities... 74
Ion Exchange..... 80
Process Equipment 96
Feature Articles
Pressure Drop 160
Corrosion Control....163
You & Your Job
Individual Performance.173
Design Notebook 175
Operation & Maintenance 178
Corrosion Forum
Heat Exchangers 184
Firms in the News.....191
Calendar 200
More New Equipment....202
Technical Bookshelf.....216
Technical Literature 220

Mobile induction welder spurs field piping..... 96

Field welder turns out completed, high-quality butt joints in only one and one-half minutes, slashes cost of plant construction and overland pipelines.

What's happening to linear polyethylene?..... 86

It looks like polypropylene and medium-density poly may capture some of the markets. After a boisterous buildup, over-capacity will run 200-300 million lb./yr. through 1962.

Here's a way to more accurate cost estimates..... 155

New factors for ratio estimates can give you fast, accurate plant equipment costs. All you need to figure direct cost is unit equipment cost and equipment schedule.

Estimate viscosity for low-pressure gases..... 169

Here's a critical look at today's best methods for estimating viscosity. It's the beginning of a new major section of our award-winning series on estimation of properties.

More tips on operation and maintenance..... 178

Mechanical seals: When you order them, the manufacturer can help; but he needs some information on the job they're going to do. And: Safety committees can help cut accidents.

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F-2 **COST NO MORE THAN ORDINARY FITTINGS**

Specialization pays off in stainless welding fitting quality. It makes possible use of production methods which put the metal in the best condition for corrosion resistance. We are the industry's only specialist in corrosion-resistant welding fittings — and have had more stainless piping experience than any other fittings manufacturer — since 1927.

FLOWLINE fittings are made to specifications which exceed the requirements of applicable A.S.T.M., A.S.A., and M.S.S. codes. Elbows, returns, stub ends, tees, reducers, caps, crosses, and 45° laterals are available from stock through leading distributors. Special fittings and flanges can also be supplied. Write for Bulletin 414A.

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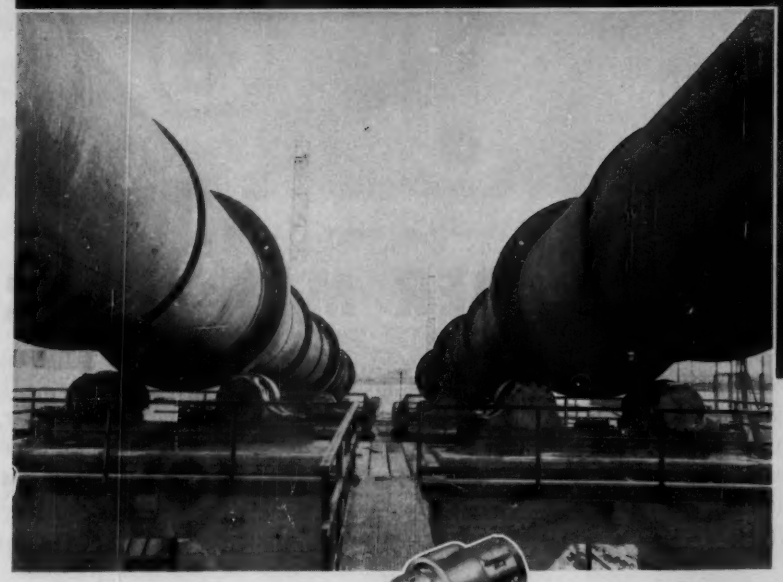
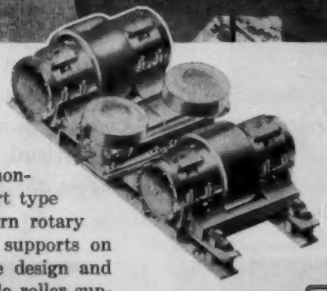
TRAYLOR-MADE

is engineering leadership



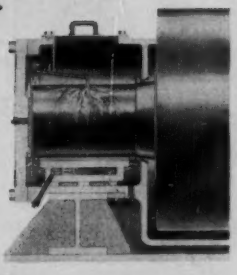
ROTARY KILN

Two 9'-6" dia. x 377'-0" Traylor Rotary Kilns in a Portland cement plant.



THRUST ROLLER MECHANISM WITH TWO BEARINGS SUPPORTING THE ROLLER TIED TOGETHER SO THAT A RIGID MOUNTING IS OBTAINED.

Leadership in engineering is demonstrated by the Traylor single support type roller bearings. Efficiency of modern rotary kilns depends largely on the roller supports on which they run. Traylor offers the design and perfection of the easy aligning, single roller supports, used on Traylor Rotary Kilns, Coolers, Dryers and Slakers. Traylor Engineers have over fifty years experience in rotary kiln design and manufacture—for more on Traylor-Made kilns write for bulletin No. 1115 today!



OIL RESERVOIR AND OILING MECHANISM DISTRIBUTING OIL OVER THE SHAFT IN A SINGLE SUPPORT ROLLER BEARING.

Traylor

TRAYLOR ENGINEERING & MFG. CO. 1090 MILL ST., ALLENTOWN, PA.

Sales Offices: New York — Chicago — San Francisco

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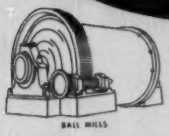


BALL MILLS

ROTARY KILNS

APRON FEEDERS

PRIMARY GYRATORY CRUSHERS

JAW CRUSHERS

SECONDARY GYRATORY CRUSHERS

How proper equipment selection results in...

MORE PRODUCTION PER MAN HOUR

With constantly rising labor costs, alert manufacturers have begun programs designed to *increase the productivity* of labor per hour through better planning, better methods and better equipment. In materials handling particularly, increased efficiency and more productivity per man hour can result in substantial savings in over-all production costs.

New Tractor-Shovel Designs

As an example of what is taking place in the bulk-material handling field is a new tractor-shovel recently introduced by The Frank G. Hough Co. The new "PAYLOADER" model H-25 has practically the same physical dimensions as its predecessor, the Model HA, yet it will carry 2500 pound loads as compared to the previous carry capacity of 2000 lbs. This means that the same operator picks up and carries 25% more material each trip — or you have increased your operator productivity by 25%.

Ease and Speed of Handling

Equally important are faster traveling speeds, a selection of gear ratios; easier operation and quicker maneuvering, because these factors affect the number of trips the operator can make. Obviously the more trips back and forth the operator makes, the more material he delivers per hour.

Power-steer and power-shift ease operator effort, speed the work cycle and boost production per man hour.

Torque converter drive gives easy, accurate "inching" control for close-quarter work. No tiring foot clutch.

More carrying capacity per load, and more loads per shift step up operator productivity substantially.

Again referring to this machine, the inclusion of power-steering; full-reversing, two-speed-range, power-shift transmission; torque-converter; plus simplified control cut operating cycle time substantially . . . resulting in more trips per hour with far less operator fatigue.

It all Adds Up to More Production

By carrying more material per trip and by making more trips per hour, the productivity per man hour is increased substantially with resulting savings in over-all costs.

What Size Machine For Your Job?

How much material do you have to move per hour or per shift? How far must it be moved? Will it be done indoors or outdoors? Do you need extra-high dumping clearance to fill bins or vats? Are there jobs in addition to bulk material handling that the machine can do? These are some of the questions that are involved in the selection of a tractor-shovel or *any* bulk material handling system.

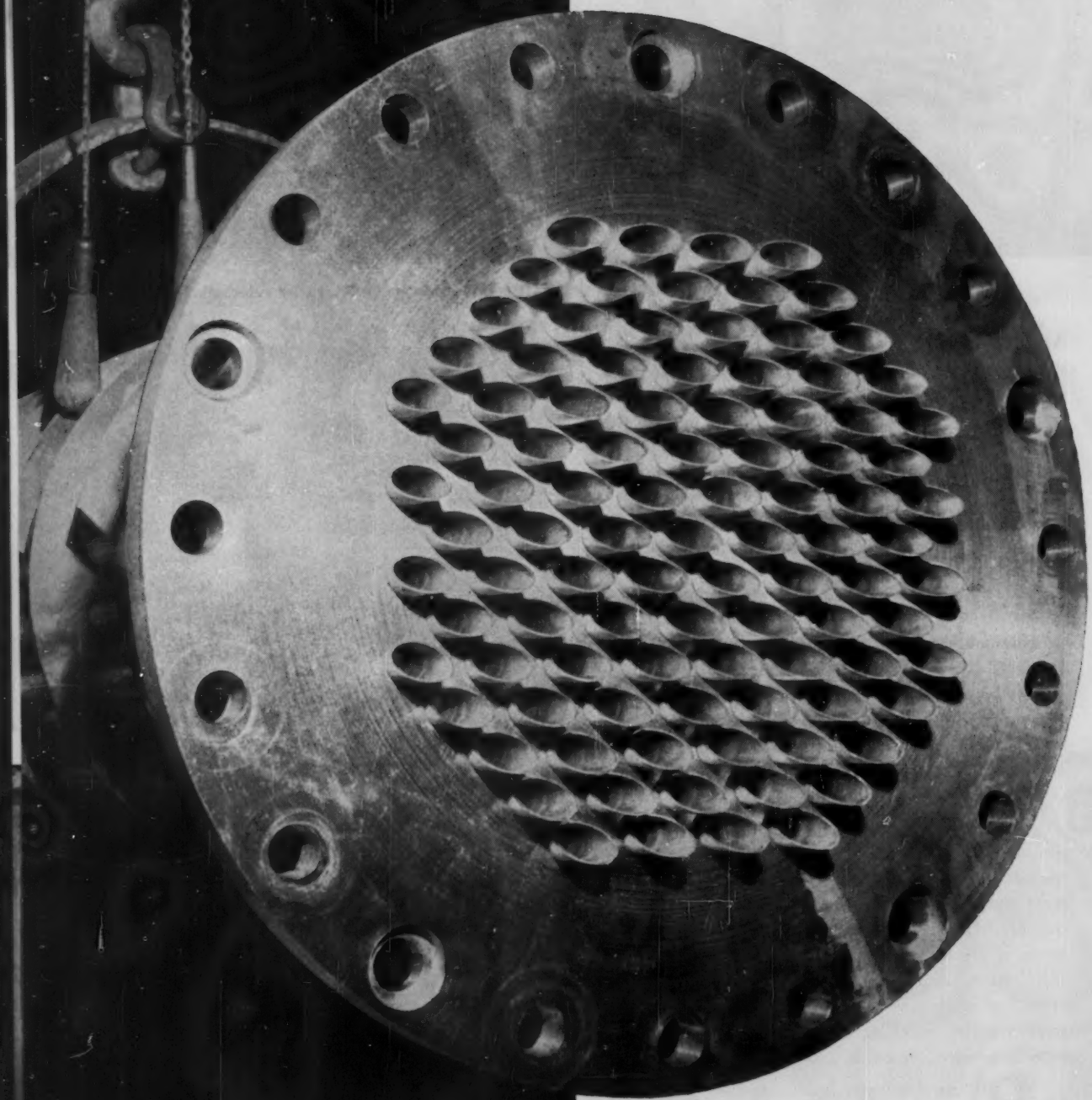
The wide selection of "PAYLOADER" tractor-shovels — 7 sizes with carry capacities from 2,000 to 9,000 lbs. — plus the different types and dumping heights that are available make them applicable to many more bulk-handling jobs than ever before. In addition, the choice of available attachments is greater than ever — attachments that enable a "PAYLOADER" to do many other handling jobs. There are crane hooks, side booms, lift forks, log grapples, hydraulic scrap grapples, backfiller and snow blades, snow plows, pick-up sweepers, back-hoes and others.

Your Hough distributor is ready to show you how you can get more production per man-hour with the new H-25 or a larger "PAYLOADER". Ask him about Hough Purchase and Lease Plans too. The Frank G. Hough Co., 754 Sunnyside Ave., Libertyville, Ill. 9-A-1

Use one man and larger "PAYLOADER" units like this model HAH (3,000 lb. carry capacity) when working space permits.

Big 4-wheel-drive units carry up to 4½ tons . . . go "anywhere" . . . dump over bin and hopper edges up to 12 ft. high.

Working with Aluminum



is a Talent at...

Vulcan manufacturing

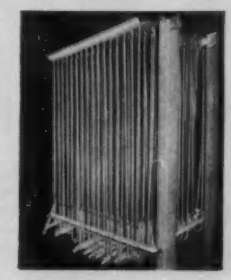
In the application illustrated at the left, Vulcan Manufacturing successfully designed and built this large heat exchanger of type 3003 aluminum.

We do not consider this unusual.

It does, however, indicate to you a talent for working with the various metals and special alloys that are more and more becoming a part of today's process equipment. This heat exchanger is typical of the wide variety of custom designed process components engineered and fabricated at Vulcan and now in successful operation. This also includes fractionating towers, extractors, evaporators, and special pressure vessels. And it encompasses wide experience with many materials including copper, stainless steel, carbon steel, aluminum, nickel, Everdur, Monel, Inconel, Hastelloy, Carpenter 20, Karbate — even plastics.

We'd like the opportunity to put this experience to work for you. For more information, call or write:

Copper . . .
and Everdur were combined in the fabrication of this condensing section



Stainless . . .
type 316 was used for this ultrahigh vacuum fin tube condenser

Monel too!
Used here on a bubble cap tray for a chemical reaction tower

Vulcan manufacturing

120 Sycamore Street, Cincinnati 2, Ohio, Dunbar 1-1400

Designers and builders of process equipment

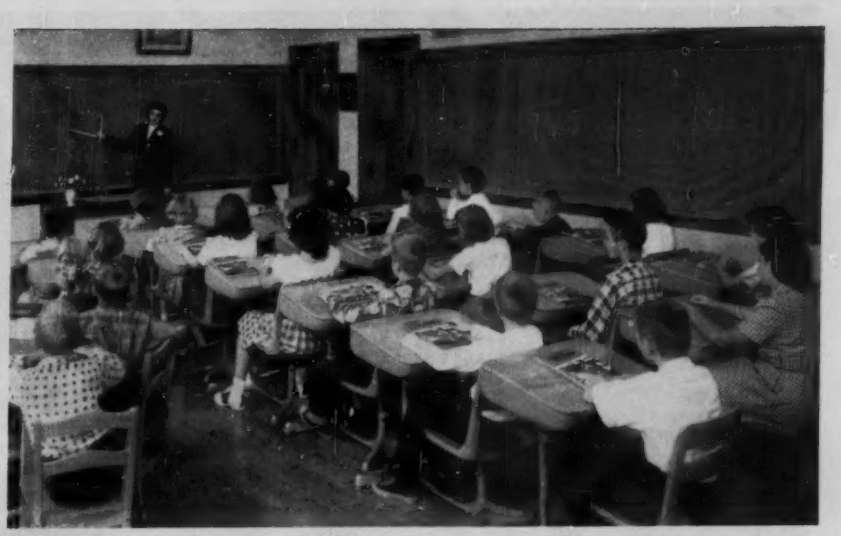
VUL-603

Life on the Chemical Newsfront

SPLASHES DON'T MATTER! High water-spotting resistance is developed after only 24 hours by interior flat wall paints formulated with CYAQUA® *alkyd emulsion*. This unique water-dispersed emulsion makes it possible to formulate paints with the beauty and durability of an alkyd combined with the ease of application and cleanup of a latex. Paints dry quickly, adhere well to all surfaces, develop high scrub resistance, clean up easily with water and have no odor. Processing advantages rival its application benefits. **(Plastics and Resins Division)**

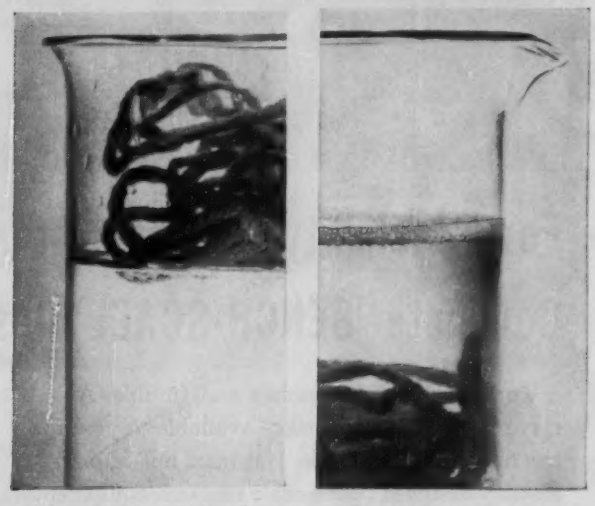
RADIOACTIVE TRACERS are among modern research tools being used at the new Cyanamid Research Center at Bound Brook, N. J., to measure efficiency of pigment dispersions in new vehicles. Basic studies are being aimed at a better understanding of the theoretical aspects of pigment vehicle interfaces and at developing new areas of interest to Cyanamid's Pigments Division. In the broad pigment research activities at Bound Brook, major emphasis is being placed on finding new chemical structures with the high degree of durability desired for coloring plastics and exterior finishes. **(Research Division)**

DURABILITY OF MODERN LAMINATED SCHOOL DESK TOPS is tremendously improved by the use of urea-formaldehyde resin adhesives. These adhesives are used to hot- or cold-press the plywood cores and also to bond the decorative surfacing laminates to the cores. Adhesives, coating resins and molding compounds are only a few of the end products that have made urea a basic raw material of industry. As the list of such products grows, so does the need for greater and greater quantities of urea. To help meet the growing demand, Cyanamid is now offering AERO* *crystal urea.* Details and technical assistance are available on request. **(Industrial Chemicals Division)**
*Trademark



A NEW DISPLAY, illustrating the history of papermaking, has just been added to American Cyanamid Company's exhibit hall at Rockefeller Center, 40 West 49th Street, in New York City. This display also gives particular emphasis to many new and unusual uses for paper made possible by the progress of the Paper Industry. Cyanamid's permanent exhibit hall has created widespread interest, drawing more than a quarter-million visitors so far this year.

TO ACCENT A LOVELY LADY'S CHARM with the exotic orange blossom fragrance of Yara Yara—or to compound a spray that will kill carpet beetles—takes only the versatile intermediate, *beta*-naphthol, and the ingenuity of the chemist in reacting it with other compounds. *Beta*-naphthol combines the economy of a bulk chemical with an excellent reaction potential. Some of its derivatives are staples in today's chemical technology; others are still laboratory curiosities. They range from artificial fragrances and flavorings to dyes and polyethylene antioxidants. Research chemists wishing to evaluate this economical intermediate may find data accumulated by Cyanamid of value. **(Organic Chemicals Division)**

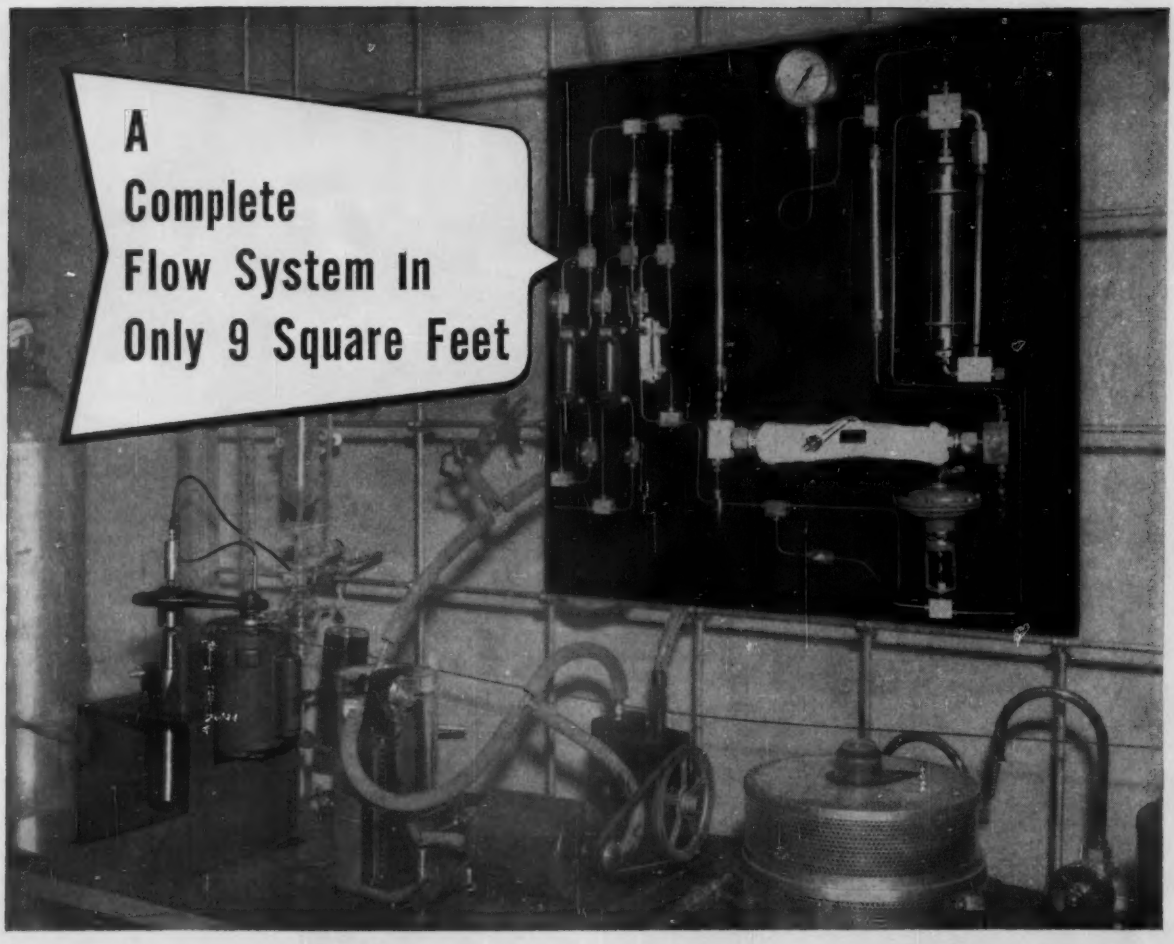


HIGH WETTING POWER of DECERESOL® *wetting agents*, important in many textile-treating operations, is demonstrated above. Yarn floats on plain water in the tumbler on the left, but sinks rapidly in water containing 0.025% DECERSOL wetting agent OT in tumbler on the right. This high wetting action promotes rapid wetting out of fabrics in scouring, desizing, bleaching, dyeing, finishing and other processes. Other DECERESOL wetting agents offer unusual combinations of solubility, emulsifying, detergent, salt-tolerance and wetting properties. **(Organic Chemicals Division)**

CYANAMID

AMERICAN CYANAMID COMPANY
30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

For further information on these and other chemicals, call, write or wire American Cyanamid Company



For Feasibility or Exploratory Studies In YOUR Lab...
Complete BENCH-SCALE Research Equipment From AE

To save you time, money and trouble, Autoclave Engineers now makes available to you, for the first time, *a complete integrated* line of *professionally designed* bench-scale research equipment for pressures up to 5000 p.s.i. Included are valves, fittings, autoclaves, reactors and auxiliary vessels.

This AE BENCH-SCALE equipment enables you to carry out in your own laboratory a wide variety of preliminary investigations such as feasibility studies before proceeding with scaled-up operations . . . research studies where only minute or limited quantities of expensive materials are available . . . batch, semi-batch or continuous reactions . . . and many other exploratory studies.

Best of all are the savings in space, time and money you'll realize with this equipment. You *save space* because every unit is specifically designed for bench-scale work. You *save time* in setting up or altering the system because of simplicity of design and resultant ease of assembly. And you *save money* because the equipment is easily and quickly assembled by your own laboratory personnel—neither skilled craftsmen nor special tools are required.

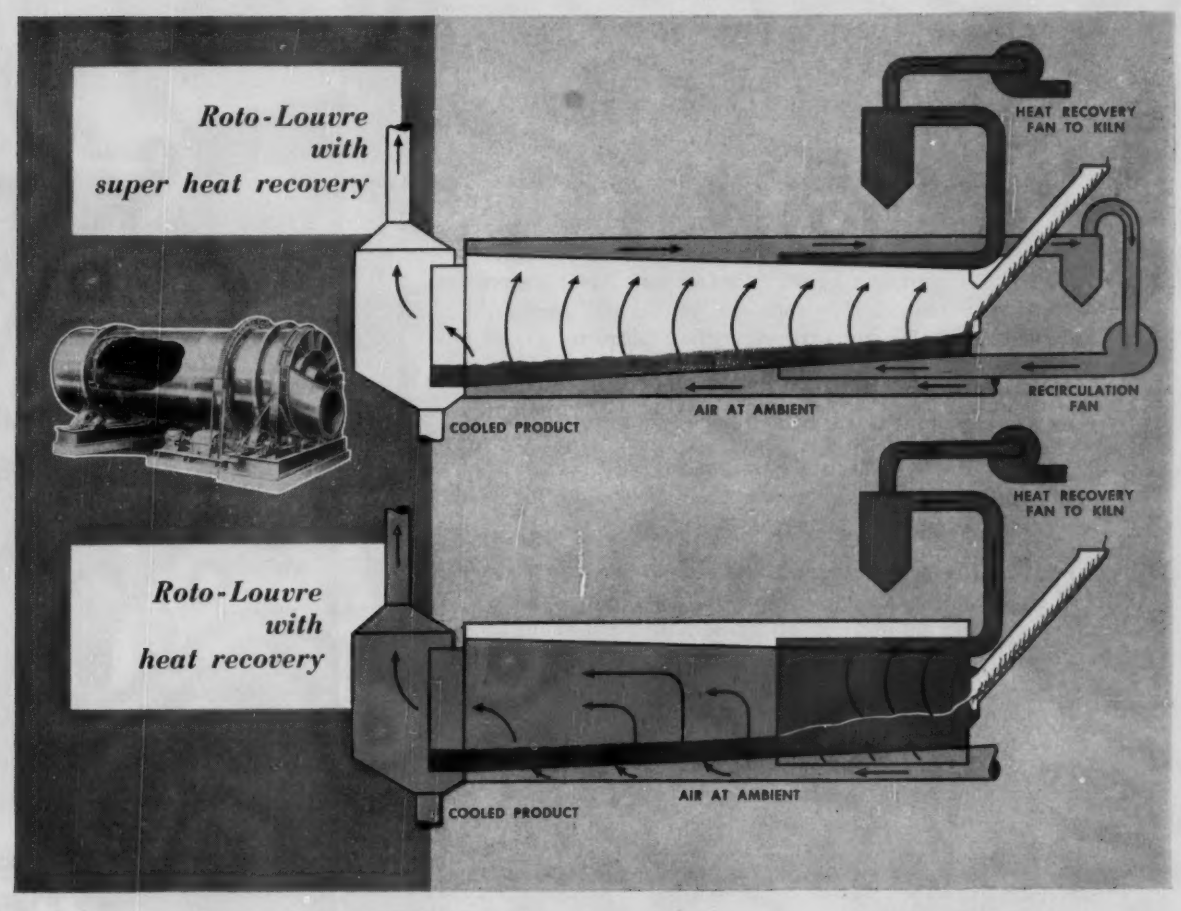
Detailed information on AE BENCH-SCALE Research Equipment is given in Bulletin 658. Send for your copy today.

AUTOCLAVE ENGINEERS, INC

2932 WEST 22nd STREET, ERIE, PENNSYLVANIA

Put waste heat to work

with a LINK-BELT Roto-Louvre cooler



LINK-BELT design salvages as much as 60% of heat for use in processing

WHERE heat from cooling can be profitably used in other processes . . . make the most of it with Link-Belt Roto-Louvre. The Roto-Louvre absorbs more heat from material being cooled than other types of coolers for a given capacity.

Roto-Louvre coolers are available with two types of recirculation arrangements, depending on desired extent of heat recovery. For maximum savings, coolers with super heat recovery permit a second passage of air over the material.

Roto-Louvre's operating efficiency is also exceptional. Material tumbles over itself in a gentle, rolling action. This not only results in uniform cooling, but also eliminates product breakage and abrasion of louvres.

A Link-Belt cooler specialist will be glad to estimate the heat conservation you can expect with Roto-Louvre. Contact him through your nearest Link-Belt district office.

LINK-BELT

COOLERS • DRYERS • ROASTERS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World. 14.9??

Holiday destination-

Saturday problem: Damaged 8,000 gallon reactor

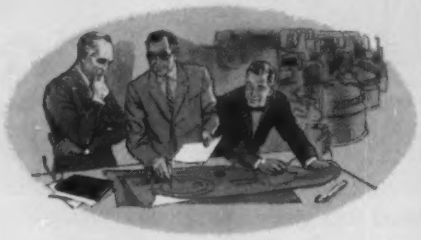
Sunday job: Trouble-shoot and repair

Monday result: Reactor back "on-stream"

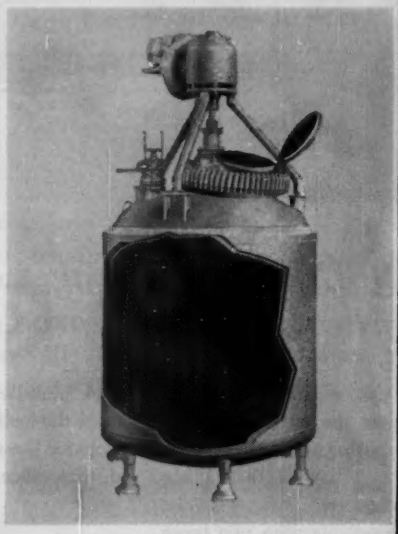
It's nine Saturday night. Home phone rings long distance. It's a Texas customer's voice: "One of our 8,000 gallon reactors was damaged. How soon can you fix it?" Answer: "Trouble-shooter leaving earliest flight." Glascote service engineer packs. Takes-off 7 a.m. Sunday. Repairs completed 10:30 that night. Monday — and he's up early. Repairs inspected. Reactor started up and back "on-stream."

Case in point: Every Glascote customer is automatically enrolled in our life-long preventive maintenance and flight-fast service programs!

Our objective: *Protecting profitability of your Glascote glass-lined equipment.* This basic protection program includes process engineering and consulting help, in-plant seminars and specialized field service.



What's behind the Glascote sales engineer . . . and his glass-lined products? He's an experienced engineer who can give you on-the-spot product and process assistance. And behind him—38 years of Glascote experience in manufacturing glass-lined vessels and tanks for the process industries. Through continual research and development engineering, Glascote stays ahead of the demand for new and improved processes requiring a wider range of corrosion, temperature and thermal shock-resisting properties for glass linings.



Custom and Standard Reactors — Designs include the HR (Heavy-duty closed), CR (clamp-top), SR (standard closed) and the new spherical reactor. Capacities range from 300 to 8,000 gallons dependent on design.

Glascote®

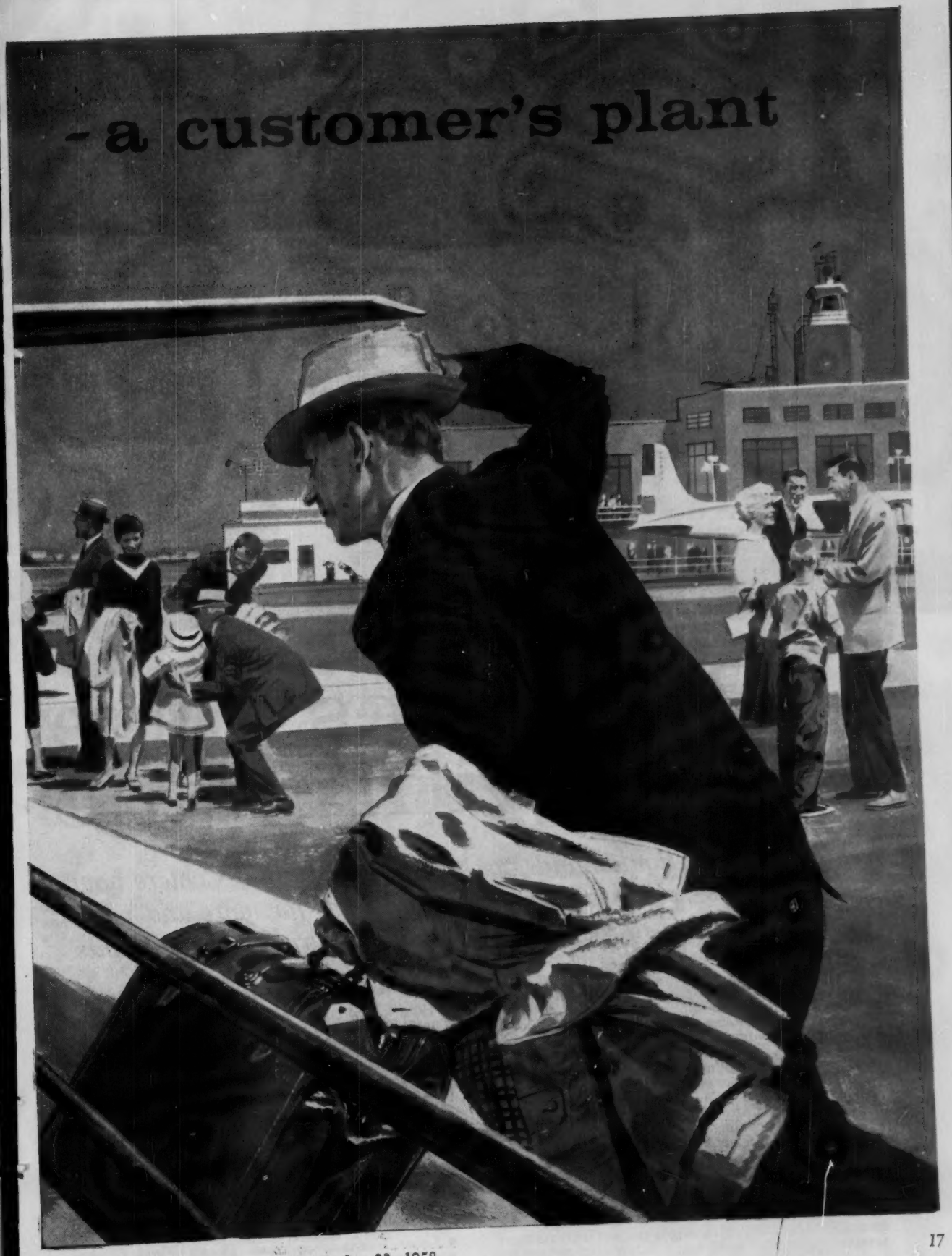
PRODUCTS, INC

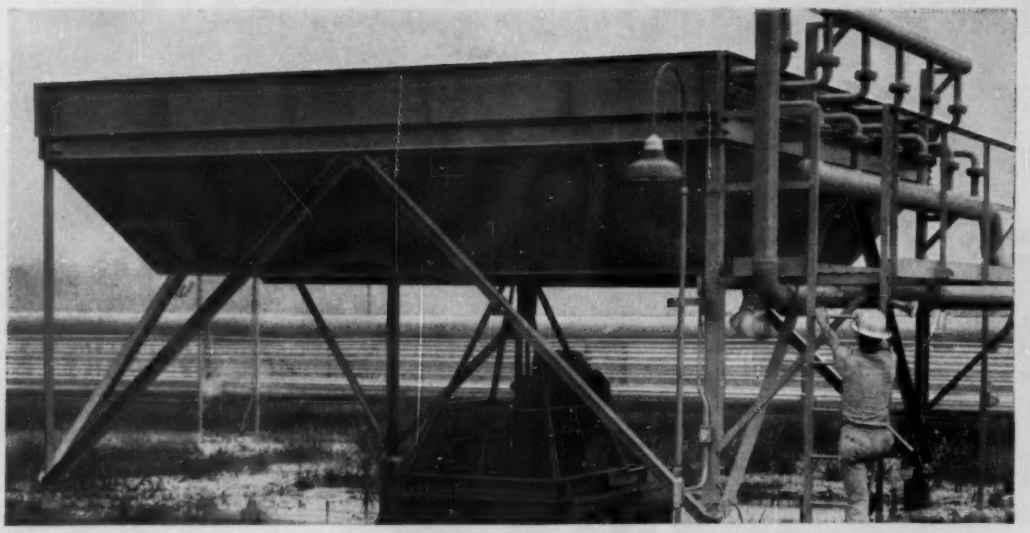
CLEVELAND 17, OHIO

Sales offices or agents in principal cities. Export sales: A. O. Smith International S. A., Milwaukee 1, Wisconsin, U. S. A.

A SUBSIDIARY OF **A. O. Smith** CORPORATION

World's largest manufacturer of glass-protected steel products


- a customer's plant



TRANE FLUID COOLERS cool either liquid or gas, condense vapors, with air as the cooling medium. Model shown is a vertical air discharge unit. Horizontal discharge units also available—both types in a complete range of capacities.

Refineries solve with Trane

Air-cooling of liquids and gases with Trane Fluid Coolers now cutting costs, solving water supply problems for more and more refineries, chemical, petro-chemical and natural gasoline plants

Engineers and plant designers have found that air-cooled heat transfer equipment can eliminate costly maintenance and water supply problems encountered with conventional water cooling towers.

Leading companies in the chemical processing field are now using two basic methods to take advantage of lower cost air cooling. One way is to design the plant for over-all higher operating temperatures. Where this is not practical, it is possible to use air cooling at the higher temperatures—and to limit the use of more expensive water cooling to "trim" cooling.

Here's how to combine air and water cooling for maximum economy: To cool from 400° down to 100°, cooling by water costs approximately the same at every level of cooling. However, lower cost air cooling with TRANE Fluid Coolers can be used from 400° down to about 130°—with water units used to cool from 130° down to 100° during periods of high ambient temperatures. This results in a substantial net reduction of over-all cooling costs and water consumption.

Here are some of the advantages of cooling with TRANE Fluid Coolers:

- *Low first cost.* When all factors are considered (including the special concrete basins . . . erection time and costs), an air-cooled TRANE Fluid Cooler installation compares favorably with cooling towers of equal capacity—especially in Northern climates. And TRANE Fluid Coolers are easier to install; fan, motor and gearbox are factory-aligned on a single metal base. All framework parts are pre-drilled and match-marked for easy erection.
- *Lower cost per year.* TRANE Fluid Coolers are rugged—have a normal life-expectancy of 15 to 20 years—compared with 7 to 10 years for cooling towers.
- *Lower maintenance costs.* TRANE Fluid Coolers normally need only periodic cleaning of the fin-tube

water problems air coolers

surface. No need for costly maintenance crews . . . spare parts . . . special maintenance facilities and equipment due to scaling, fouling and corrosion of water-cooled equipment.

• *Lower real estate costs.* TRANE Fluid Coolers are compact, simple—can often be erected on roofs or over other equipment, saving land area.

• *Performance.* TRANE Fluid Coolers are available with Admiralty stainless and carbon steel tubing to meet the most rigid specifications. And, unlike many manufacturers, TRANE makes all its own coils, has had over 30 years' experience in this highly specialized field.

NEW BULLETIN AVAILABLE! *Write today for illustrated catalog S-395. Illustrates use of TRANE Fluid Coolers in power generation . . . gas transmission . . . industrial and process cooling. Address The TRANE Company, La Crosse, Wisconsin.*

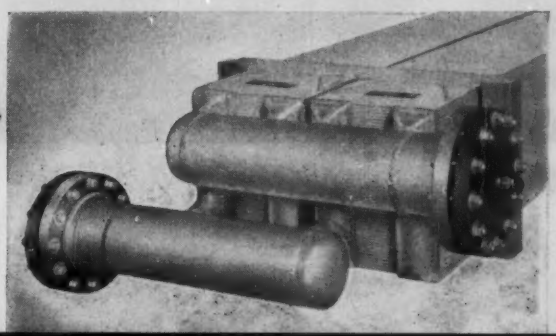
FOR LOW TEMPERATURE processing of gases and liquids at low cost, install compact TRANE Brazed Aluminum Heat Exchangers. Field-proven performance since 1951 in over 60 installations for production of oxygen, nitrogen and argon, for hydrogen purification in ammonia plants and other operations. TRANE Brazed Aluminum Exchangers pack up to 450 sq. ft. of heat transfer surface in 1 cu. ft. Low installation as well as operating costs. Highly efficient performance at temperatures below —300°F, with temperature approaches of 5°F. Operating pressures as high as 600 psig. May be headered for multi-stream operation, combining as many as four exchangers in one unit.

For any air condition, turn to

TRANE

MANUFACTURING ENGINEERS OF AIR CONDITIONING, HEATING, VENTILATING AND HEAT TRANSFER EQUIPMENT

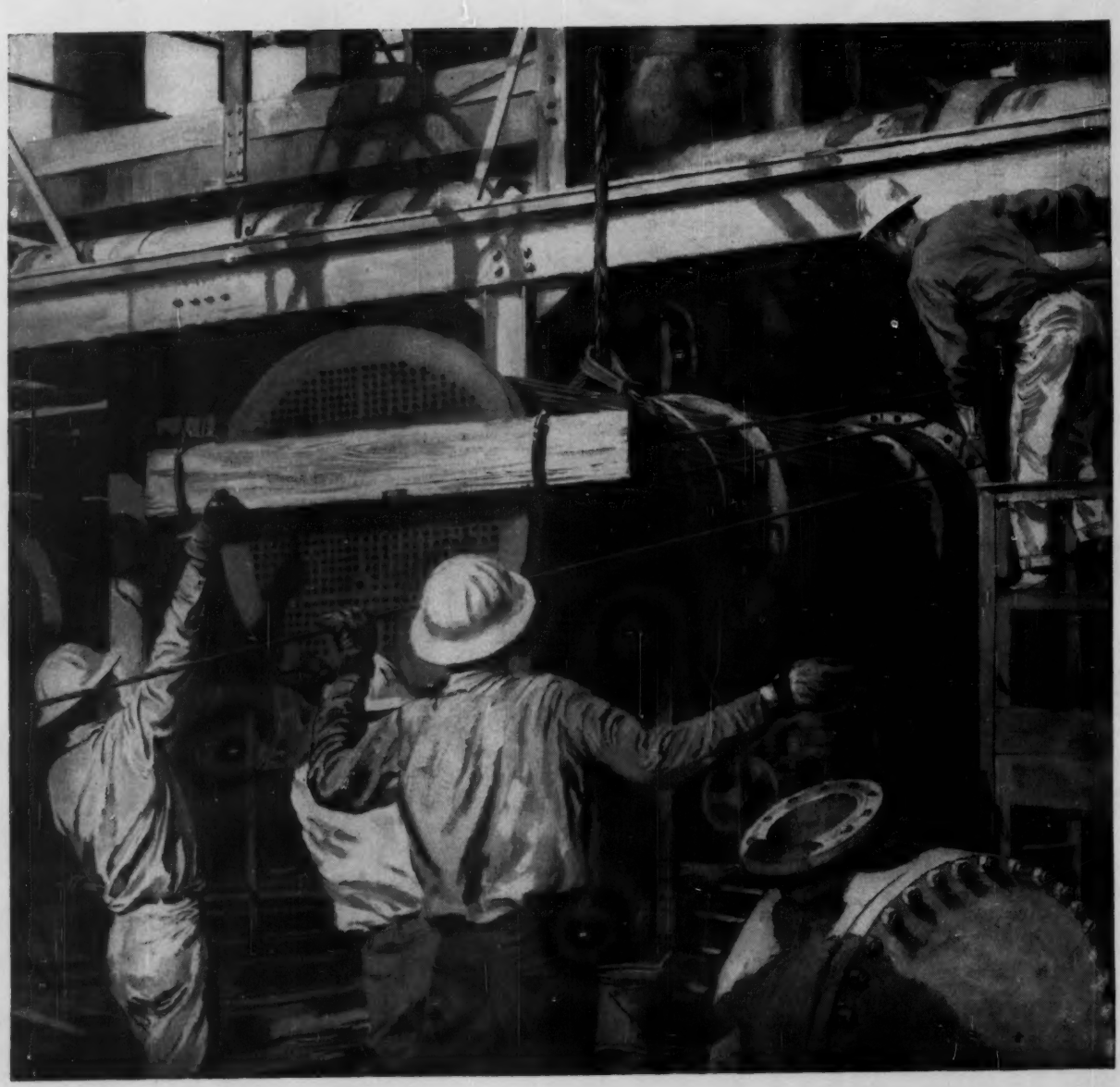
THE TRANE COMPANY, LA CROSSE, WIS. • SCRANTON MFG. DIV., SCRANTON, PA. • CLARKSVILLE MFG. DIV., CLARKSVILLE, TENN. • TRANE COMPANY OF CANADA, LIMITED, TORONTO • 97 U.S. AND 19 CANADIAN OFFICES



RETUBE YOUR BUNDLES WITH

PHELPS DODGE HEAT EXCHANGER AND CONDENSER TUBES

FOR LONG-RUN RELIABILITY!



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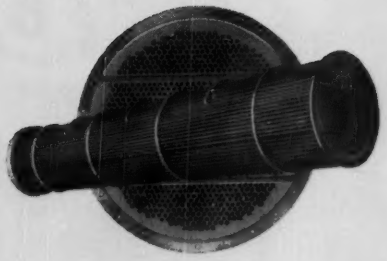


- Wide range of finest quality copper-base alloys—bi-metal combinations—to fit your application needs.
- Well-stocked, nation-wide warehouses at Houston, Tulsa, Los Angeles and Bayway, N. J.
- Experienced engineering staff at your service to help solve tube corrosion problems.

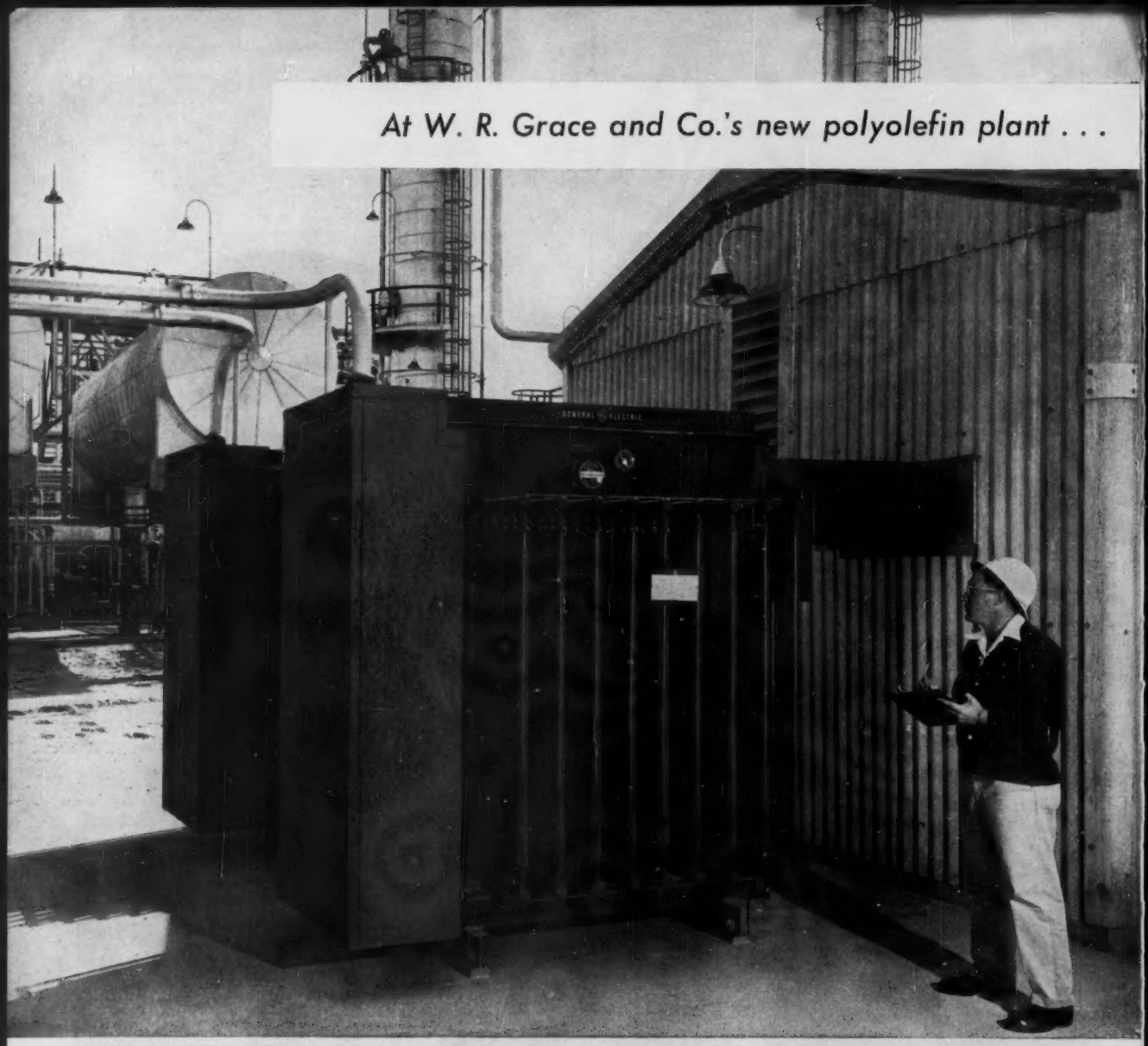
Specify Phelps Dodge . . . a leading manufacturer of tubes for the fabricators of heat exchangers and condensers!

PHELPS DODGE COPPER PRODUCTS CORPORATION

SALES OFFICES: Atlanta, Birmingham, Ala., Cambridge, Mass., Charlotte, Chicago, Cincinnati, Cleveland, Dallas, Dayton, Detroit, Fort Wayne, Greensboro, N. C., Houston, Indianapolis, Jacksonville, Kansas City, Mo., Los Angeles, Memphis, Milwaukee, Minneapolis, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Ore., Richmond, Rochester, N. Y., San Francisco, St. Louis, Seattle, Washington, D. C.

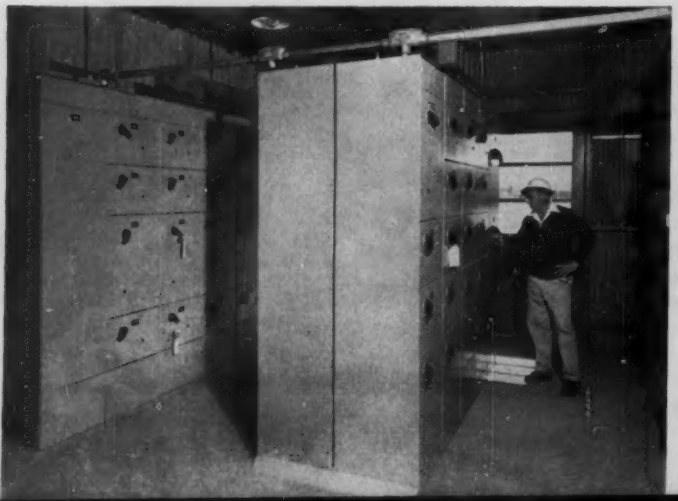
FIRST FOR LASTING QUALITY—FROM MINE TO MARKET!

At W. R. Grace and Co.'s new polyolefin plant . . .



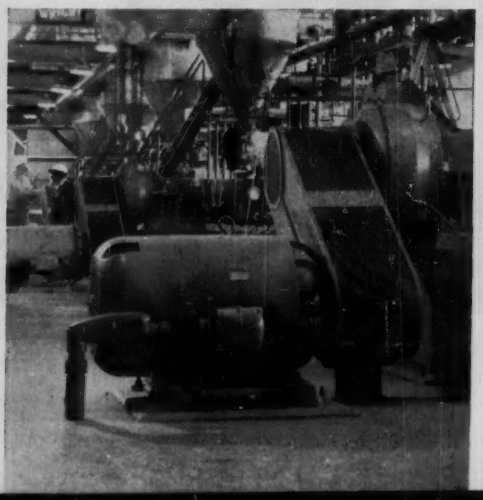
RELIABLE G-E TRANSFORMERS are easy to install, easy to maintain. Transformers pictured are rated 1,000-KVA.

PRE-ASSEMBLED, PACKAGED nature of General Electric motor-control centers greatly reduced installation costs at new Grace and Co. polyolefin plant. Equipment costs were less because remotely located centers did not require extra-protected equipment.



RELIABLE, LONG LIFE General Electric 150-hp induction motors drive extruders which compress GREX† pellets in their final form.

†Registered Trade-mark of W. R. Grace and Co.



OPERATION upturn
Buy now for extra values
GENERAL ELECTRIC

Standardization on General Electric equipment cut spare parts inventory by 60%

Here's how single-source purchasing and expert system-engineering assistance cut installation time and costs, and saved valuable floor space for the Polymer Chemicals Division of W. R. Grace and Co.

Because standardization on General Electric motors, controls and switchgear permitted maximum parts interchangeability, W. R. Grace and Co., reduced anticipated spare parts inventories by 60 per cent at their new Baton Rouge polyolefin plant. Now, spare parts for their entire electrical system occupy less than 1 per cent of their warehouse area, making valuable space available for production items.

In addition, G-E engineering know-how and system-engineered electrical products helped cut installation time and costs at this new 50 million pound petrochemical facility.

Unit responsibility is the key to these major reductions. Because of the many and varied applications in this plant, W. R. Grace and Co. officials felt that standardization on one supplier was the most efficient and economical way to do the job. Previous experience with G-E equipment and technical assistance encouraged their choice of General Electric.

The pre-assembled, complete-packaged nature of G-E substations, switchgear and motor-control centers greatly reduced installation costs at this W. R. Grace and Co. plant. The remote location of the control equipment—made possible by the principle of the motor-control center—eliminated the need for expensive, specially-protected equipment.

Over 300 rugged G-E induction motors, ranging from fractionals to 150-hp, are spotted throughout the 30-acre site to provide the power required to keep the plant running 24 hours-a-day. These extra-protected motors drive pumps, agitators, extruders, mixers, conveyors and rotary valves. Built for longer life, even under tough refinery conditions, these G-E motors require less maintenance, keep downtime to a minimum.

If you plan to build a new plant, or expand your present facilities, General Electric offers the system-engineered equipment and the technical assistance to provide you with an economical, efficient electrical system. Contact your nearest General Electric Apparatus Sales Office for complete information. General Electric Company, Schenectady 5, New York.

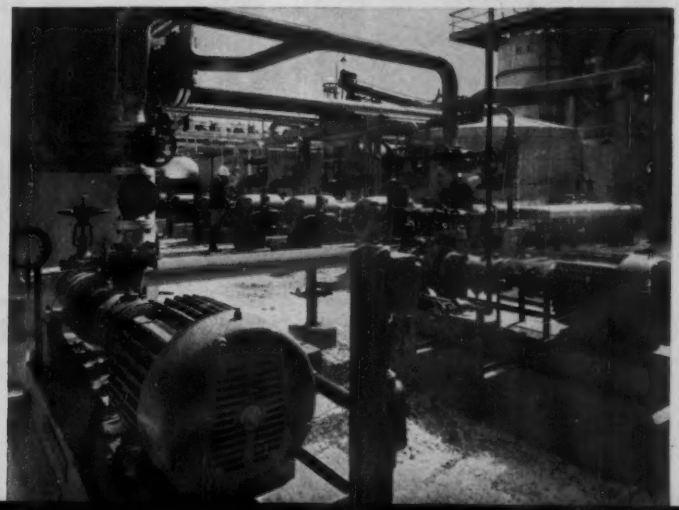
681-16

Engineered Electrical Systems for the Petrochemical Industry

GENERAL ELECTRIC

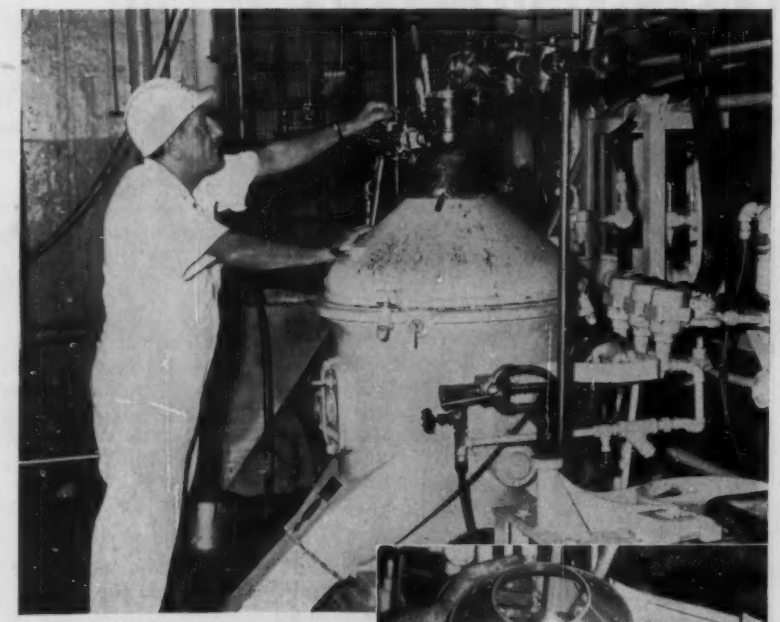
FOR GREATER MAINTENANCE FLEXIBILITY, G-E AK-25 air circuit breakers can shut off small parts of plant when repairmen are at work. 1200-amp breakers are also used as large motor starters.

RUGGED TOTALLY-ENCLOSED and explosion-proof G-E Tri-Clad* '55' motors provide extra protection and greater safety required for some refinery applications. More reliable Tri-Clad motors require less maintenance, reduce system shutdowns. *Reg. Trade-mark of General Electric Co.

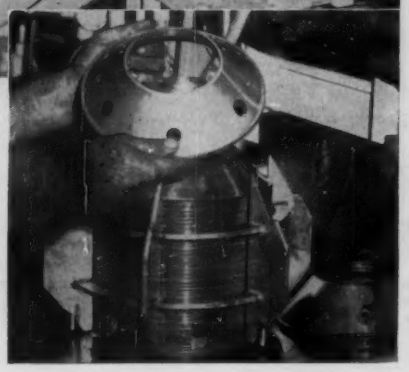


PFAUDLER

Lederle Labs up enzyme production 140% with Titan Superjector



Solids both lighter and heavier than the effluent are separated with ease by this Titan Superjector at Lederle Laboratories Division of American Cyanimid Company.



A monthly cleaning is the only major maintenance required with the Titan, since it desludges itself thoroughly during operation.

Problem one

To get a certain enzyme, Lederle Laboratories have to pull it out of a slurry that runs 15% to 50% solids.

Problem two

The clogging problem presented by this thick slurry is aggravated by the presence of solids both lighter and heavier than the enzyme liquid.

Solution

What to do? After careful study, Lederle engineers settled on the Titan Superjector whose special disc design and method of desludging achieve the most difficult separations with ease.

The liquid feeds down the center of the Titan and out at the lower edge of the center tube so that it enters the disc stack from the bottom.

It then rises through aligned holes in the discs. Separation starts at the holes and is intensified by particle contact with the disc bottoms.

The Titan's action forces the liquid enzyme up to the top of the bowl where it is decanted continuously. Solids lighter than the liquid get trapped at the center of the bowl. Heavier solids slide to the periphery where they are collected by settling vanes.

Slots around the outside of the bowl, ⅜" high by 5" long, open automatically to pre-set cycles and desludge both types of solids in a span of seconds.

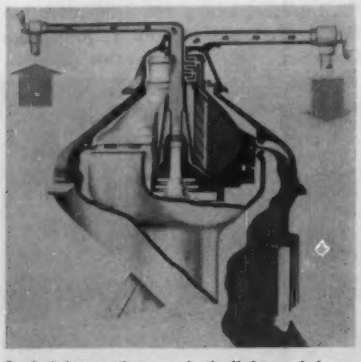
The Titan keeps running during desludging so there is minimal loss of production time.

Result

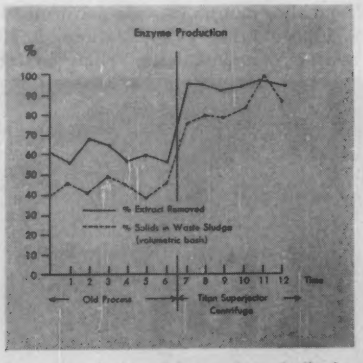
Since installing the Titan, Lederle Labs have boosted enzyme output from 25 to 60 gph—a phenomenal increase of 140%. See graph at left. Sludge now goes directly into the plant's sewage system and causes no problem whatsoever. Maintenance consists of routine lubrication and a monthly clean-out.

How about you?

If you have a difficult separation problem, you'll surely want to know more about this machine. With it you can separate solids from one or even two liquids at speeds up to 6000 gph, exerting up to 7800 G's. Just check the coupon for a bulletin.



Desludging action on both light and heavy solids is shown in this cross-section of the Titan Superjector. Desludging is automatic and can be set to any time cycle desired.



Enzyme production shot up dramatically immediately after Lederle Laboratories began using the Titan Superjector. Notice the high percentage of enzyme separation.

CORROSIONEERING NEWS

New glassed flush valve

. . . available on O. E. M. discounts

Head and stem on this new valve are one piece and glassed. The seat is rigidized Teflon-glass fiber and its bevel mates with that of the spherical shaped head. The Teflon has some "give" so you can get a firm seating without danger of damaging the head.

This design is interchangeable with existing valves you might now be using and costs no more than a conventional stainless steel valve. Sizes range from 1½ by 1 to 8 by 6.

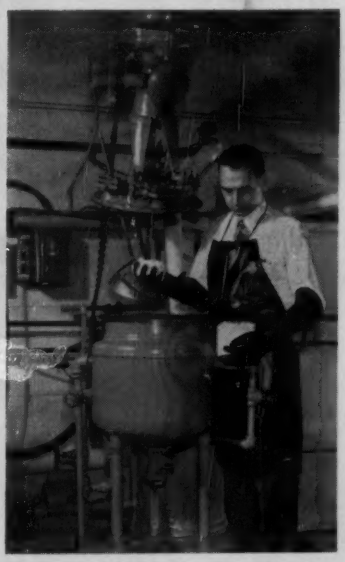
Check coupon for more data.

Protect manholes with this new plastic chute when you dump a charge.

Pfaudler glassed steel takes a lot of abuse, but this chute offers still further insurance against damage to the manhole flange when you dump abrasive or solid materials. This inexpensive chute slips onto the flange easily and protects the entire neck of the opening. Check the coupon for Data Sheet 43 for more details.

Chlorine dioxide and glassed steel

Chlorine dioxide is much in the news since various methods have been devised for safely generating and taming this highly corrosive and explosive oxidizing agent.



The Mead Corporation uses this 10-gallon glassed-steel Pfaudler reactor in its continuing study of chlorine dioxide as a pulp bleaching agent. Two years of work with solutions ranging from eight to twenty grams of chlorine dioxide per liter have left the glassed steel unmarred.

Our own experience with chlorine dioxide, going back some years now, has reached the point where our engineering can size and equip a complete generating plant using the process of your choice.

Our interest here is natural, since the making of chlorine dioxide involves a host of other corrosives, among them sulfuric acid, sulfur dioxide, methanol, and sodium chlorate.

Glassed steel invariably proves the most practical and economical material for handling all these corrosives.

In the typical chlorine dioxide installation, you will find glassed steel at work in sodium chlorate and sulfuric acid storage tanks, generators, columns, waste liquor storage tanks, chlorine dioxide storage tanks, and in pipe, fittings, valves and pumps.

We are familiar with all the generating systems in common usage and work closely with the licensors to save customers as much as possible from the detail work of putting a system to work.

If you have thought of using chlorine dioxide for pulp bleaching, or water treatment or the bleaching of fats, oils, flour, etc. you will benefit from investigating further the use of glassed steel.

CHEMICAL EQUIPMENT by PFAUDLER

a division of PFAUDLER PERMUTIT INC.,

Dept. CE-98, Rochester 3, N. Y.

Please send me ☐ Bulletin 946, Titan Superjector; ☐ Data Sheet DS-42, Flush Outlet Valve; ☐ Data Sheet 43, Dump Chute; ☐ Bulletin 968, New Buyer's Guide

Name.....

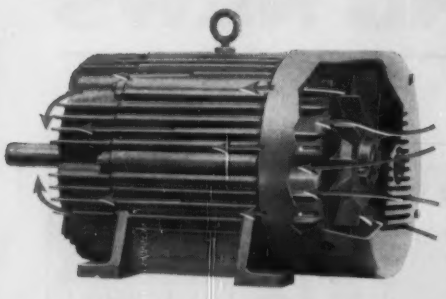
Title.....

Company.....

Address.....

City.....Zone.....State.....

See Chemical Engineering Catalog, pp. 1407-1418 for complete Pfaudler line.



The original C-W fin-cooled, self-cleaning design which provides more cooling area—no internal passages to clog.

ELLIOTT C-W EXPLOSION-PROOF MOTORS

self-cleaning . . . self-cooling

Designed especially for hazardous locations

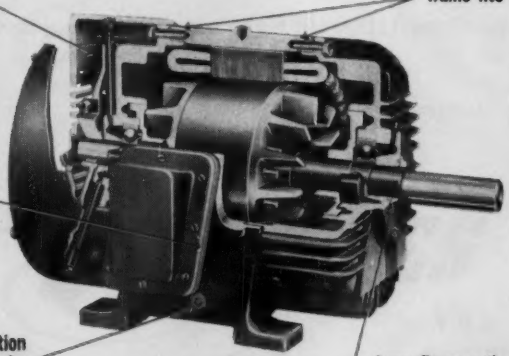
Elliott explosion-proof sealedpower motors are approved by Underwriters' Laboratories for applications in hazardous locations, indoors or outdoors. They have an excellent service record in refineries, natural gasoline plants, pipe lines, chemical plants, etc. . . . wherever explosive atmospheres may exist. NEMA frames through 505, ratings to 100 hp. Ask your Elliott representative for detailed literature *today*.

ELLIOTT Company

CROCKER-WHEELER PLANT, Jeannette, Pennsylvania

W 8-9

5 important construction features provide safety and reliability


Non-sparking external fan
Long bracket-to-frame fits
Close-tolerance metal-to-metal fits; leads sealed where they leave frame
Approved combination automatic drain and breather—easy to get to
Long flame path and rotating slinger

Underwriters Approved—for Class I, Group D, frames 182 through 256U . . . for Class I, Group D, frames 284U through 326U . . . for Class I, Group D and Class II, Groups F and G, frames 364 through 505

Greater Capacity . . .

. . . Higher Pressures

for Solids Dewatering

SHARPLES ADVANCED DESIGN CENTRIFUGES

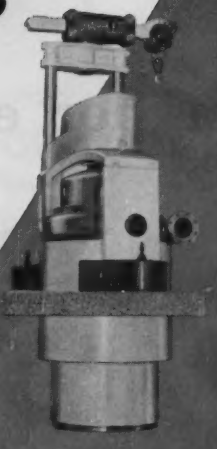
P-7000 SUPER-D-CANTER — The largest of six sizes of continuous scroll type solids discharge centrifuges for the clarification of crystalline or amorphous solids . . . The P-7000 will handle solids at rates in excess of 12-15 tons/hr. *For operation at pressures to 150 psi.*

SUPER-D-HYDRATORS — These high efficiency crystal drying centrifuges are available in 3 sizes, the largest of which has a capacity on ammonium sulphate in excess of 20 tons/hr. *For operation at pressures to 150 psi.*

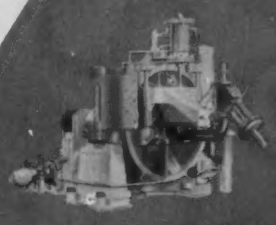
DH-6 NOZLJECTOR — Designed to handle feeds in excess of 500 gallons per minute. This is the largest of 3 sizes of continuous solids discharge nozzle type centrifuges for the clarification and concentration of solids in slurries and sludges. *For operation at pressures to 150 psi.*

Sharples is setting new standards of capacity and all-round performance with the only really new centrifuges being offered today. If a solids dewatering step is necessary in your processing, it will pay you to get the facts from Sharples.

Your inquiry will be given our prompt attention.



P-7000 VERTICAL SUPER-D-CANTER



SUPER-D-HYDRATOR for dewatering crystals

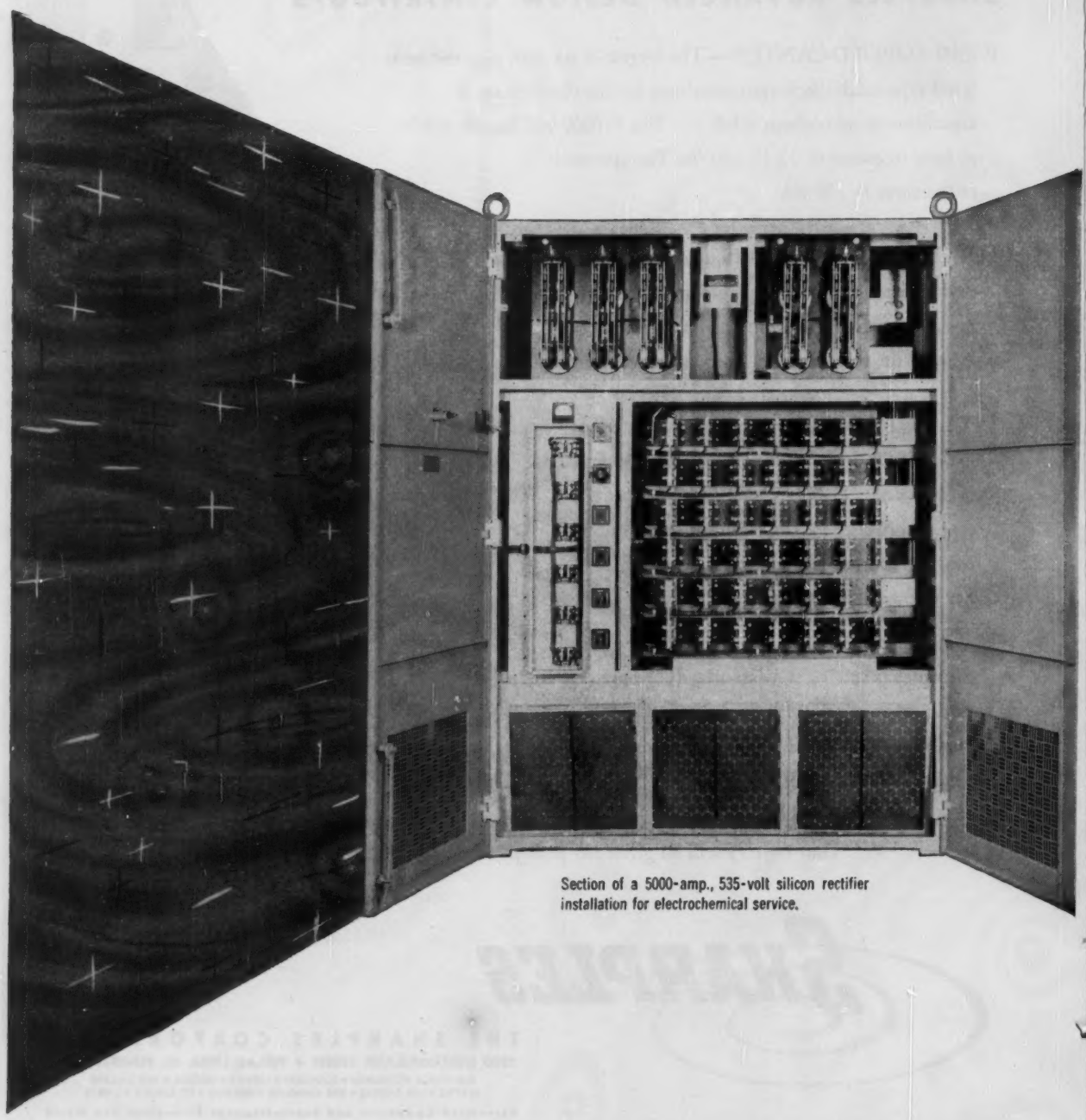
* The bowl (rotor) of a pressurized DH6 NOZLJECTOR—the largest and highest capacity nozzle type centrifuge available to industry.

SHARPLES

THE SHARPLES CORPORATION
2300 WESTMORELAND STREET • PHILADELPHIA 40, PENNSYLVANIA
NEW YORK • PITTSBURGH • CLEVELAND • DETROIT • CHICAGO • NEW ORLEANS
SEATTLE • LOS ANGELES • SAN FRANCISCO • HOUSTON • ST. LOUIS • ATLANTA
Associated Companies and Representatives Throughout the World

Westinghouse Silicon Rectifiers...

higher efficiency, simpler construction



Section of a 5000-amp., 535-volt silicon rectifier installation for electrochemical service.

for medium and low voltage

electrochemical processing economy

Helping you curb the high cost of processing is the job of these new air-cooled, high-efficiency Westinghouse silicon rectifiers. Cost of power — as reflected in final product costs — is now made lower than ever before.

Low cost . . . advanced circuitry eliminates complicated excitation equipment and simplifies construction.

High efficiency . . . approximately 95% overall, for low and medium voltage applications.

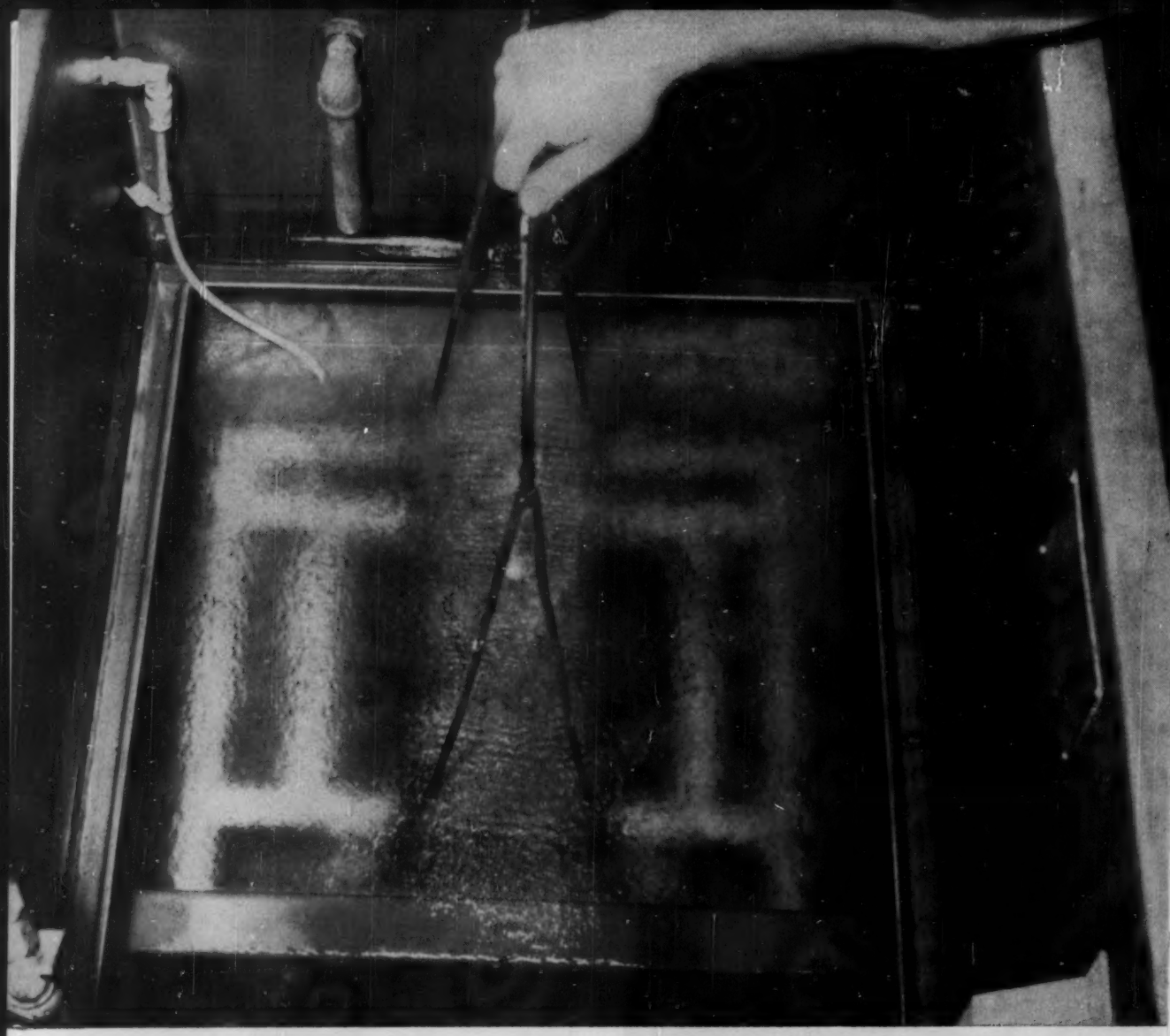
Long life . . . no detectable aging of silicon cells has occurred even after many years of use.

Ease of installation . . . units are completely factory-assembled. You need only make a-c and d-c connections.

No costly outages . . . indicating equipment will detect cell failure. Drawout construction makes replacement quick and easy without dropping load.

For full information on Westinghouse silicon rectifiers for electrochemical applications, call your Westinghouse representative or write Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pennsylvania. J-15008

YOU CAN BE SURE...IF IT'S **Westinghouse**



This unit cleans machine parts with solvents and ultrasonic waves. The walls are made from Stainless Steel because Stainless resists corrosion and will not contaminate the parts being cleaned.

Only Stainless Steel can stand high-frequency vibrations in cleaning units

The Detrex Chemical Industries, Inc. of Detroit has developed a method of cleaning machine parts with 10-second exposures to ultrasonic waves in vats of trichlorethylene.

Stainless Steel is the only metal that can be used in these vats. They tried others but found that in time the ultrasonic waves shook loose tiny specks of corroded metal from the vat walls and dropped them on the cleaned machine part.

With Stainless Steel vats there are no tiny specks of corrosion. The Stainless takes these high-frequency vibrations every day and it doesn't even show a pin-point spot in its hard, smooth finish.

When you buy new equipment for your plant, think about corrosion-resistant Stainless Steel. If you want service-tested quality, specify USS Stainless Steel. *USS is a registered trademark*

United States Steel Corporation–Pittsburgh
American Steel & Wire–Cleveland
National Tube–Pittsburgh
Columbia-Geneva Steel–San Francisco
Tennessee Coal & Iron–Fairfield, Alabama
United States Steel Supply–Warehouse Distributors
United States Steel Export Company

USS **United States Steel**

ONE OF A SERIES

Printed by offset lithography on 70-lb. paper containing Wyandotte PURECAL® in the coating.

After the sale...what?

(The "why" of Wyandotte technical service)

Many years ago, we learned that if we were going to introduce new chemicals which had unique characteristics, some form of application help was necessary.

We also discovered that buyers were asking themselves: "Is my supplier reliable? What about his product? Are his research facilities adequate for our needs? Will I get quick action from him when I need service?"

From these needs grew our present-day concept of technical service.

At Wyandotte, technical service is an integrated part of our over-all operation. It crosses all corporate lines. It is ever-present in procurement of raw materials, research, manufacturing, sales, shipping, and, of course, servicing.

It encompasses many activities including: furnishing such fundamental information as chemical and physical properties along with other pertinent characteristics of our products; recommending handling procedure; inspecting manufacturing operations in our plants and in those of our customers (on request); instructing customers' personnel on safety measures.

In addition, our technical service is responsible for quality control, packaging and loading, complaint handling, and all-around trouble-shooting in the customers' behalf.

Why do we do all this?

Because we've found that good technical service builds customer satisfaction, insures product success, avoids emergencies.

We have also learned by experience that, in order to be good, technical service must be deep-rooted and sincere.

And, while you may never require Wyandotte technical service in your plant, it's an assuring feeling to know that it is operating in our organization continuously in your behalf.

For a pictorial presentation of Wyandotte technical service in action, turn the page.

WYANDOTTE CHEMICALS

SODA ASH • CAUSTIC SODA • BICARBONATE OF SODA • CALCIUM CARBONATE • CALCIUM CHLORIDE • CHLORINE • MURIATIC ACID • HYDROGEN • DRY ICE GLYCOLS • SYNTHETIC DETERGENTS (anionic and nonionic) • CARBOSE® (Sodium CMC) • ETHYLENE OXIDE • ETHYLENE DICHLORIDE • PROPYLENE OXIDE • PROPYLENE DICHLORIDE • POLYPROPYLENE GLYCOL • DICHLORODIMETHYLHYDANTOIN • CHLORINATED SOLVENTS • OTHER ORGANIC AND INORGANIC CHEMICALS

Stretching dollars for rubbermakers

. . . an example of Wyandotte technical service at work

1 A large rubber company ran into a snag with a formulation for a new line of tires. The problem: white-sidewall tires were cracking on low mileage test runs. As one of the first steps toward a solution, the company's tire compounder called in a Wyandotte technical-service representative. Here they examine a faulty tire on a test car.

2 The problem was taken to the Wyandotte research center and turned over to scientists in the pigment-research laboratory. They studied the company's rubber compound from many angles . . . decided uneven curing rates of wall and tread components were at fault. PURECAL, Wyandotte's precipitated calcium carbonate, was introduced in formulas for white-sidewall stock—each adhering to requirements for wearability, strength, whiteness.

3 In developing these new rubber formulations, the Mooney Viscometer helped determine processing safety factors and proper viscosity flow for molding. Characterizing developmental stocks typifies Wyandotte's thorough approach to customer problems.

4 A final report containing Wyandotte's laboratory findings, along with full technical data on PURECAL, was submitted to the research director of the rubber company. It will serve as a guide for further research and development in their own laboratory.

Wyandotte
CHEMICALS

Pacing progress with creative chemistry

Wyandotte PURECAL* is solving problems for many industries . . . making better white-sidewall tire stocks, improving paints, giving smoother finishes for paper. And it's backed by the highest caliber technical service, as demonstrated on this page—available to all Wyandotte customers. If you have a problem that falls within our technological background, check with us—our approach is designed to provide answers. *Wyandotte Chemicals Corporation, Michigan Alkali Division, Wyandotte, Mich. Offices in principal cities.*

*Reg. U.S. Pat. Off.

Change motors in minutes—

with FALK *all-steel* MOTOREDUCERS

No long and costly "down time" involved

Motors can be interchanged or replaced *in minutes* with the all-steel, All-Motor type FALK Motoreducer. No long and costly "down time" is involved in making the change!

Best of all, replacement is not limited to original make of motor—new NEMA frames may be substituted for old. This versatile Motoreducer operates with any make, speed or type of standard foot-mounted motor within its AGMA rating. No modification, no special shaft, no "partial" motor required.

In addition to unmatched motor interchangeability, this dependable gear drive—the "work horse of industry"—offers: widest choice of output-shaft position (horizontal, vertical, right-angle)...any output-shaft connection...any mounting, including wall and ceiling...standard speed range from 1.5 rpm to 1430 rpm. All these advantages, plus proved efficiency, low maintenance and extra-long life, make the All-Motor type FALK Motoreducer your best buy for any job requirement.

Furnished in sizes up to 75 hp with any make, style or type of motor; or, *without a motor if desired.* FALK Motoreducers are available from convenient factory, field or distributor stocks, from coast to coast.

Write for Bulletin 3100

THE FALK CORPORATION, MILWAUKEE, WISCONSIN

MANUFACTURERS OF:

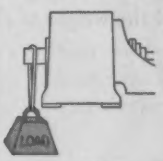
- Motoreducers
- Speed Reducers
- Flexible Couplings
- Shaft Mounted Drives
- High Speed Drives
- Special Gear Drives
- Single Helical Gears
- Herringbone Gears
- Marine Drives
- Steel Castings
- Weldments
- Contract Machining

FALK

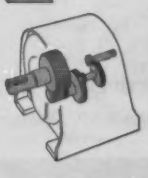
...a good name in industry

FALK "IN-BUILT" FACTORS assure full dependability—better service—longer life

ALL-STEEL HOUSINGS
Rugged, strong, rigid ...all parts heavy steel plate, formed and welded in the Falk Weld Shop.



LARGE OVERHUNG LOAD CAPACITY
Large shafts, oversize bearings...rigid mountings with wide bearing spans to handle maximum loads.



PRECISION GEARING
Heat-treated alloy steel gearing, precision cut and shaved after heat treatment to eliminate distortion.

SEALED HOUSINGS
Splashproof, dustproof, oiltight. Dual closures and one-way vents keep oil in, dust and moisture out.

HOW *HERCULES* HELPS...

create new concepts in packaging with hi-fax®

Breck gets superior plastic packaging at no extra cost with this handsome, practical and durable Hi-fax bottle.

Hi-fax, Hercules high-density polyethylene, made possible this dramatic breakthrough in plastic "carrier" packages. This Hi-fax container for Breck Banish is featherlight, unbreakable, handsomely decorated by offset printing . . . a truly modern, low-cost package for a modern new beauty product.

Plax Corporation, Hartford, Conn., producer of the new Banish bottle, now offers packagers a complete line of stock Hi-fax containers ranging in size from 32 ounces to 6 ounces. Only ⅛ the weight of glass, yet competitive in cost, these modernistic containers provide a combination of advantages possible only with Hi-fax—shatterproof toughness, heat resistance which permits post-packaging sterilization, and resistance to stress corrosion cracking. Hi-fax bottles can be safely packed and shipped in economical, lightweight containers, provide substantial savings in freight costs.

Whether you make containers or use them, why not write to Hercules for more information about how Hi-fax can help to give your product a new look.

Plax Corporation offers many opportunities for Hi-fax packages in a selection of stock and custom sizes.

HERCULES POWDER COMPANY
INCORPORATED
900 Market Street, Wilmington 99, Delaware

HERCULES

COPPUS SENTRY® VALVES

Stop flow instantly

or

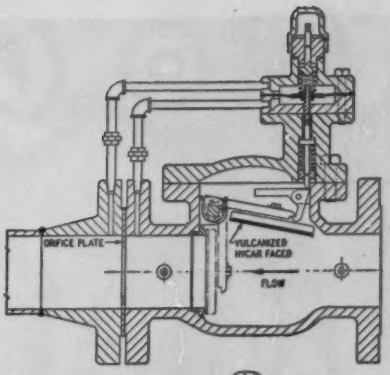
Start flow instantly

Automatically

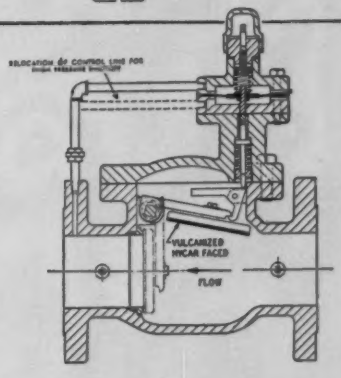
And when they flow, it's full flow

ANOTHER
COPPUS
"BLUE RIBBON" PRODUCT

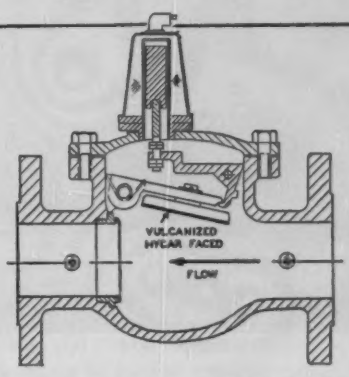
MODEL 1200 SENTRY EXCESS FLOW SHUT-OFF VALVE — shuts off gas or liquid instantly when flow exceeds predetermined rate.

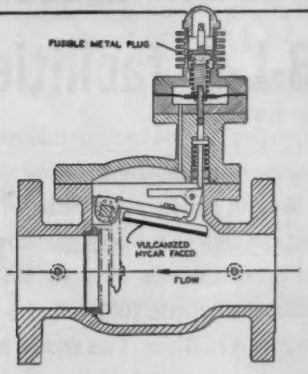


MODEL 1500H SENTRY HIGH PRESSURE AND MODEL 1500L LOW PRESSURE SHUT-OFF VALVES — shut off gas or liquid instantly when predetermined pressure limits are reached.

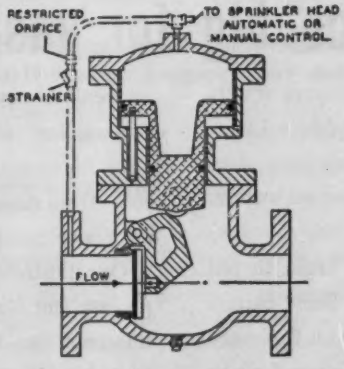


MODELS 1700 AND 1800 SENTRY SOLENOID SHUT-OFF VALVES — shut off gas or liquid instantly by remote electrical control.





MODEL 2200 SENTRY OVERPRESSURE AND OVERTEMPERATURE SHUT-OFF VALVE — shuts off gas or liquid instantly in case of excessive pressure or ambient temperature.



MODEL 3000 SENTRY PISTON OPERATED QUICK-OPENING VALVE — starts gas or liquid flow instantly when pressure in piston chamber is released. Ideal for deluge system and for automatic opening and closing by instrument-air or electrical control.

COPPUS ENGINEERING CORP.
230 PARK AVENUE
WORCESTER 10, MASS.

Please send information on Sentry Valve model 1200 ☐, 1500H and 1500L ☐ 1700 and 1800 ☐, 2200 ☐, 3000 ☐.

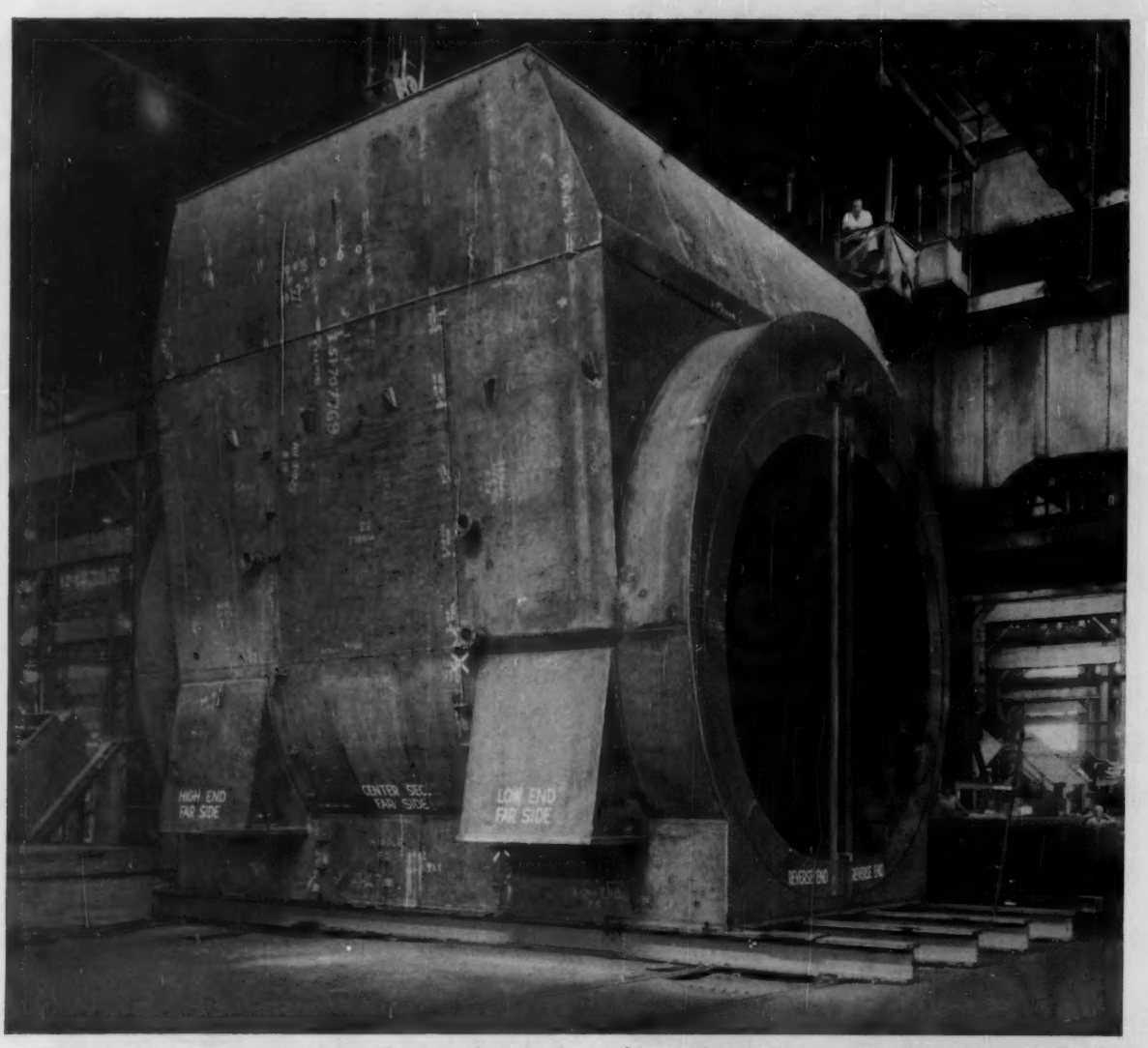
Name.....

Company.....

Address.....

City.....

State.....



Operator of overhead crane (top, right) and workmen on shop floor are dwarfed by the enormousness of this surface condenser casing fabricated by B-L-H's Eddystone Division.

No welding job too big for vast B-L-H facilities

No welding job—not even the biggest pressure vessels—is too large for the facilities of Baldwin-Lima-Hamilton's Eddystone Division. The fabricating shop covers 15 acres and is divided into 13 bays, each 80 ft. wide and 600 ft. long.

Sheer size does not, of course, even begin to tell the whole story. From automatic tracer flame cutters to individual hand welders, we have a tool for every conceivable operation. And there is no reason for you to spend money transporting formed parts to Eddystone for welding—or completed weldments to some other shop for machining. We can handle every phase of the job—from design right through to delivery. No wonder so many companies bring the big ones to B-L-H.

Our illustrated Weldment Bulletin 7001 will give you an excellent idea of our vast facilities. You should have it in your files. For a copy, write to B-L-H Corporation, Philadelphia 42, Pa.

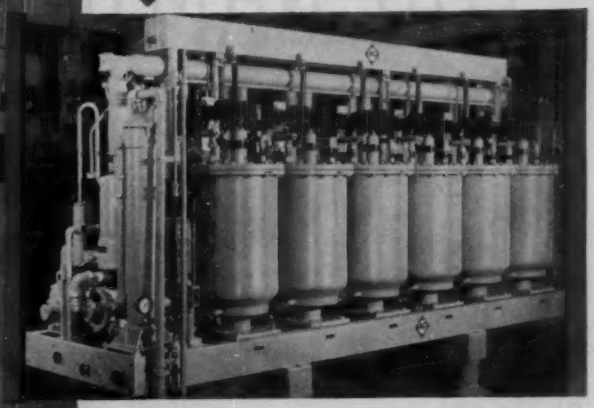
BALDWIN · LIMA · HAMILTON

Eddystone Division

Philadelphia 42, Pa.

Hydraulic turbines • Weldments • Dump cars • Nonferrous castings • Special machinery • Bending rolls • Machine tools

Open pumped tube unit permits easy access for inspection. Easy to recondition in field.



Enclosed sealed tube unit conserves space, cuts installation costs, eliminates need for vacuum pumping system.

ALLIS-CHALMERS

Mercury Arc Rectifiers

Pumped or Sealed? Open or Enclosed?

Here's how Allis-Chalmers can help you choose a rectifier for your job—

BOTH sealed and pump-evacuated tube rectifiers offer distinct advantages, depending upon the application. Whether your rectifier should be open or enclosed construction also depends on the application. Since Allis-Chalmers offers you a choice of sealed or pumped tubes in either open or enclosed construction, you get an unbiased recommendation, based on a study of your needs, and not on commercial expediency. And you can be sure of unsurpassed reliability and ease of operation, as proved in hundreds of Allis-Chalmers installations.

Only Allis-Chalmers Excitron Rectifiers give you all these important advantages—

- **Fixed excitation anode** does not contact mercury — is independent of level, turbulence or impurities.
- **Continuous excitation** eliminates need for reignition — pilot arc always present.
- **Grid phase control** located in clean region near anode where ion density is lowest.
- **Internal cooling system** provides high heat transfer with seamless tube coil.
- **Arc-over-free tube** eliminates arc-over danger by insulating entire arc path.
- **Enameled anode seals** provide high strength, trouble-free seal.

For detailed information on mercury arc rectifiers contact your nearest A-C office, or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin, for bulletin 12B8494.

A-C ALLIS-CHALMERS

ALLIS-CHALMERS

A-5560

YOU NAME IT....

26% Uranium Ore in a 1% Sulphuric Acid Solution

CHLORINATED SALT BRINE

Sulphurous Acid

Latex

Stoddard Solvent

Cellulose Acetate

Muriatic Acid

Hydrofluoric Acid

...DeZURIK WILL VALVE IT!

DeZurik Valves have been specified as the standard in many plants as the result of being installed on a "tough-to-handle" service.

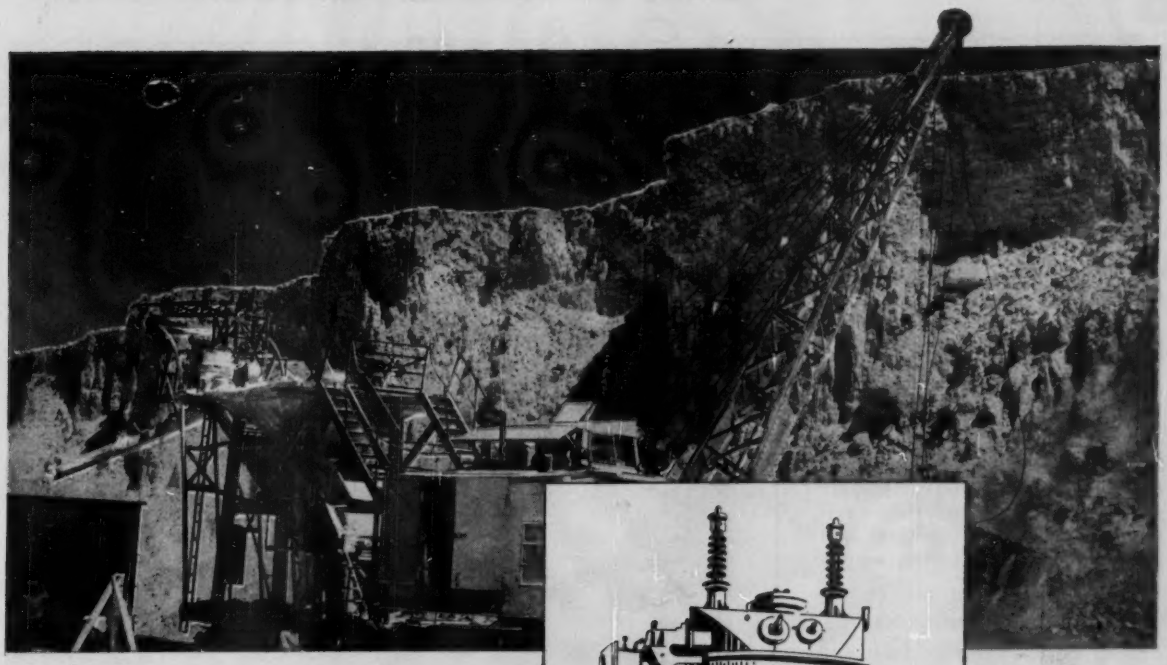
It's easy to see that if they handle the tougher services, they'll handle the easier ones with less maintenance, less trouble and they'll last longer.

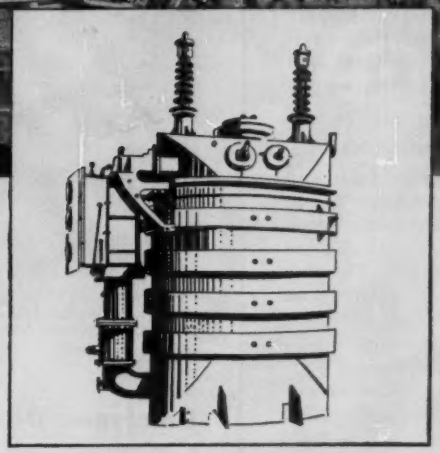
They need no lubrication (no chance for contamination!), they won't leak (no expensive process material down the drain!), and they'll withstand your toughest corrosion problems.

Let the DeZurik representative in your area give you the complete story, or write for more details on DeZurik Valves.

DeZURIK CORPORATION
SARTELL, MINNESOTA

SULPHUR *helps to create Headline Products*





SF_6

A new concept in transformer insulation

GAS INSTEAD OF OIL... *that is headline news!*

Sulphur Hexafluoride is a heavy, non-flammable gas and is both chemically and physiologically inert. These characteristics plus its high dielectric strength pin-pointed the heavy duty transformer field as a logical target. And so it turned out!

SF6 instead of oil is now being used in high voltage transformers with the following advantages:

- operations are much quieter
- lighter construction permissible
- less restriction in location
- lower maintenance
- fire-proof and explosion-proof

In SF6, the electrical and electronics industries are finding a very useful product providing both electrical insulation and cooling. As in so many 'headline' products serving industry, the element S is part of the chemical structure!

Texas Gulf Sulphur Co.

75 East 45th Street, New York 17, N. Y.
811 Rusk Avenue, Houston 2, Texas

Sulphur Producing Units
- Newgulf, Texas
- Moss Bluff, Texas
- Spindletop, Texas
- Worland, Wyoming

UNICHROME
Trade Mark

News about
COATINGS for METALS
Metallic.....Organic.....Decorative.....Protective

Improved phenolic linings extend tank life

Plastisol gives tank exteriors "lifetime" protection

Serious tank corrosion often occurs from the outside in. Solution spillage and corrosive atmospheres can deteriorate ordinary coatings and attack the metal, shorten equipment life.

ELIMINATES MAINTENANCE

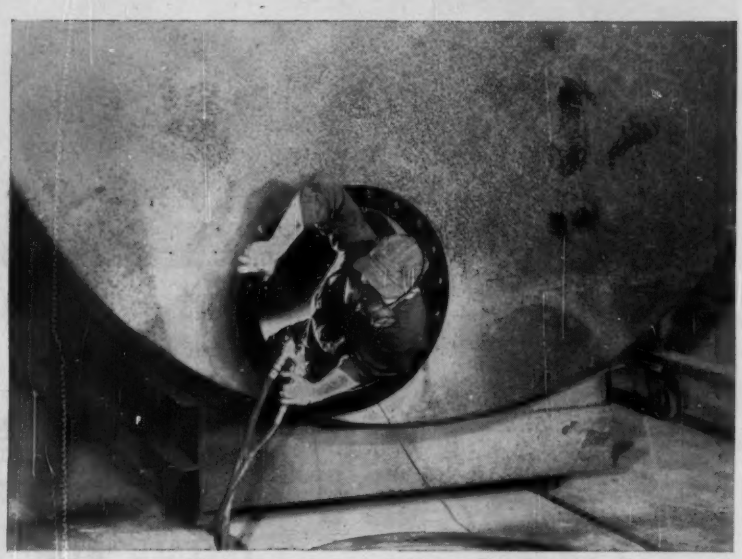
Protecting the exterior of tanks and equipment with Unichrome "Super 5300" Plastisol is good practice, good economy. Especially so where maintenance is difficult. For this same material that is protecting so many tank *interiors* makes *exteriors* corrosion resistant, too. One application usually gives lifetime protection. Non-porous and seamless, this vinyl shield stops corrosive fluids and fumes.

CAN BE PATCHED

Its flexibility and toughness help prevent impact and abrasion damage. Should patching ever become necessary, Unichrome "Super 5300" can be sprayed on, spot baked, and protection restored good as ever.

See details in your copy of "CEC", or send for Bulletin Chem C-3.

METAL & THERMIT
CORPORATION
General Offices: Rahway, New Jersey
Pittsburgh • Atlanta • Detroit
East Chicago • Los Angeles
In Canada: Metal & Thermit—United Chromium of Canada, Limited, Rexdale, Ont.



Specialists are located in key areas to apply Unichrome Phenolic Linings. They have the experience and the facilities to handle even large, difficult jobs promptly and properly.
Photo Courtesy General Coating Co., Woodbridge, N.J.

Unichrome B-124 Linings have increased resistance to impact, give thicker films, positive cure-control

Phenolic coatings continue to provide a most economical lining for tanks, tank cars, drums. Features have been incorporated into the Unichrome Series B-124 phenolics that greatly improve the physical properties...increasing their reliability still further for corrosive service.

WON'T CHIP ON IMPACT

Improved reverse impact resistance of Unichrome phenolic linings is especially valuable in containers and tanks subject to handling abuses. Linings stick tight, prevent exposure of metal, guard against corrosion and contamination of the product.

SPECIAL FEATURES

Unichrome Series B-124 Linings include materials that bake to a hard, glossy surface for an easy-to-clean final coat; others go on as thick as two mils per coat — twice that of ordinary phenolics; still another signals with a visible color change when fully cured, to assure optimum durability.

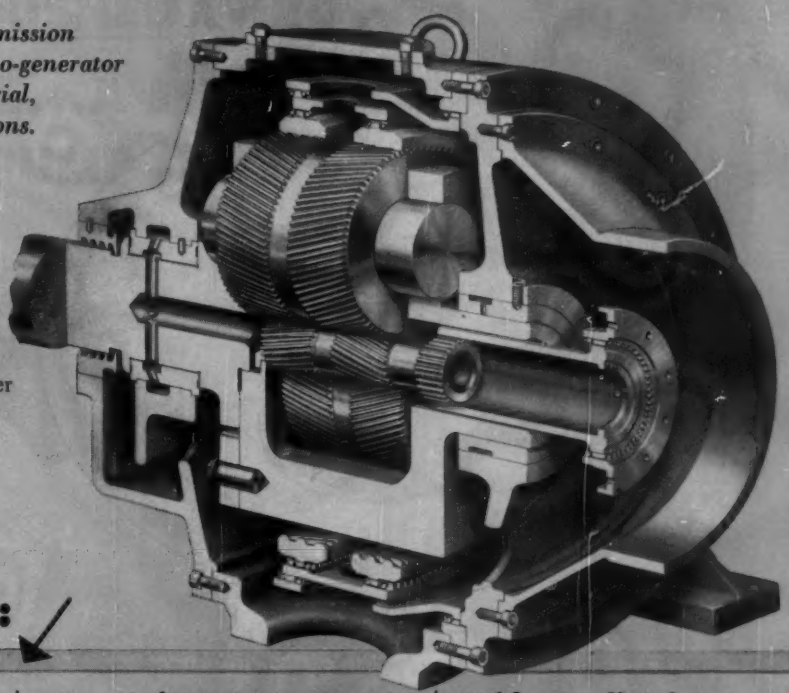
Unichrome B-124 Coatings stand up in direct contact with wide range of active materials, including strong acids and solvents. Write Metal & Thermit for information and names of nearby applicators that can give you fast service even on large equipment.

DE LAVAL-STOECKICHT
PLANETARY GEAR

...for high speeds...high horsepower

Proved in hundreds of installations abroad totalling over 3,000,000 horsepower—now available in America!

For all high torque power transmission applications such as pump turbo-generator and compressor drives in industrial, municipal and marine installations.

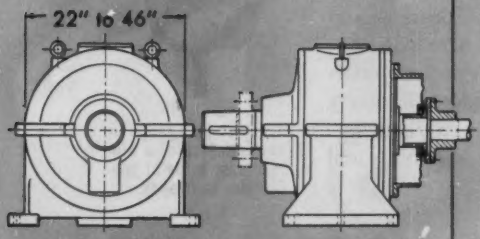


This cutaway view of the De Laval-Stoeckicht Planetary Gear shows how it provides flexibility for proper load distribution throughout the gear members. The thoroughly proved and tested design is completely reliable in transmitting high horsepower for high speed applications. • Highest efficiencies (98% or higher)... no high speed bearings... less friction losses.

Check These Advantages:

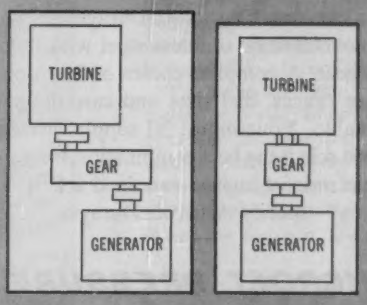
Small Size—Light Weight

Compact—low weight per hp. Sizes range from 22" to 46" in diameter, depending on horsepower requirements. Example: 5000 hp planetary unit weighs 1700 lbs. against 6000 lbs. for conventional gear.



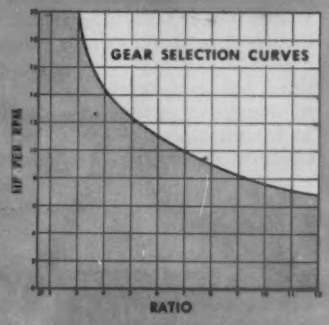
Convenient Arrangement

Co-axial or "in-line" arrangement of gear members takes up far less space than parallel axis gears of equivalent horsepower rating.



Wide Application

Capacity range shown in shaded area on chart below. For other applications, contact your De Laval Sales Engineer.



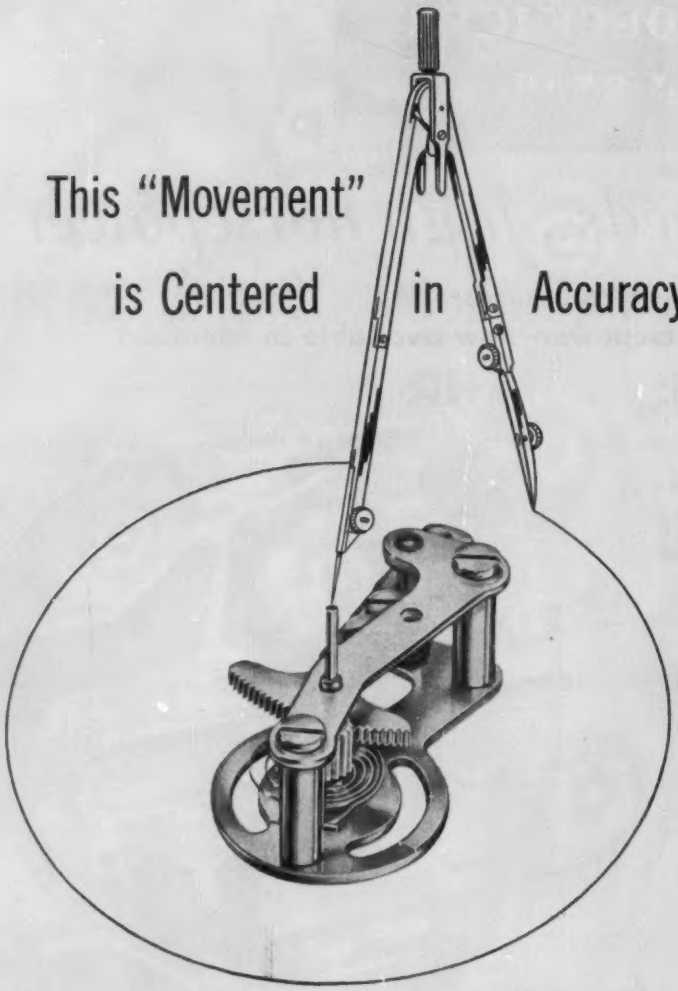
For further details, write for Bulletin 2400.

DE LAVAL *Steam Turbine Company*

803 Nottingham Way, Trenton 2, New Jersey

DL491

This "Movement" is Centered in Accuracy



The rotary movement in Ashcroft Duragauges has a geared center shaft on which the pointer is mounted. When pressure flexes the Bourdon tube, the pointer is always positively positioned. You can rely on the Duragauge for precise accuracy in measuring pressure no matter how severe the conditions of service.

Correct calibration is guaranteed: the one-piece link between movement and Bourdon tube prevents slippage or parting under tension. Recalibration is easy from front or rear. Universal adjustability permits uniformly graduated dials.

You can order Ashcroft Duragauges with all-stainless-steel movement or stainless steel with nylon bearings and pinion gear. A complete choice of Bourdon tube materials, pressure ranges, dial sizes and case designs and materials is available. Your industrial supply distributor will gladly help you select the best combination for your requirements. So, be certain of highest sustained accuracy, durability and economy – specify Ashcroft Duragauges.

Ashcroft Duragauge in Alumalife® case—a lifetime case made of special aluminum alloy.

MAXWELL MM&M MOORE, INC. MANNING TRADE MARK

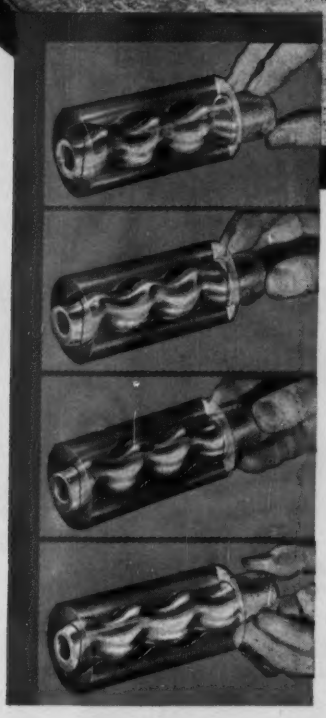
ASHCROFT PRESSURE GAUGES

A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Stratford, Connecticut
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

IF A CHEMICAL CAN BE PUSHED THROUGH A PIPE...A MOYNO® WILL PUMP IT!



Moyno's exclusive "progressing cavity" principle enables chemical plants to successfully pump hundreds of formerly "unpumpable" materials. These include highly abrasive or corrosive materials, ranging from thin watery slurries to extremely viscous material like rubber dough.

The screw-like rotor revolving in a double threaded stator moves material smoothly, without pulsation, turbulence or agitation. Because the rotor and stator can be constructed of special materials which resist wear, Moynos cut maintenance costs to a minimum.

No doubt Moynos can cut pumping costs for you!

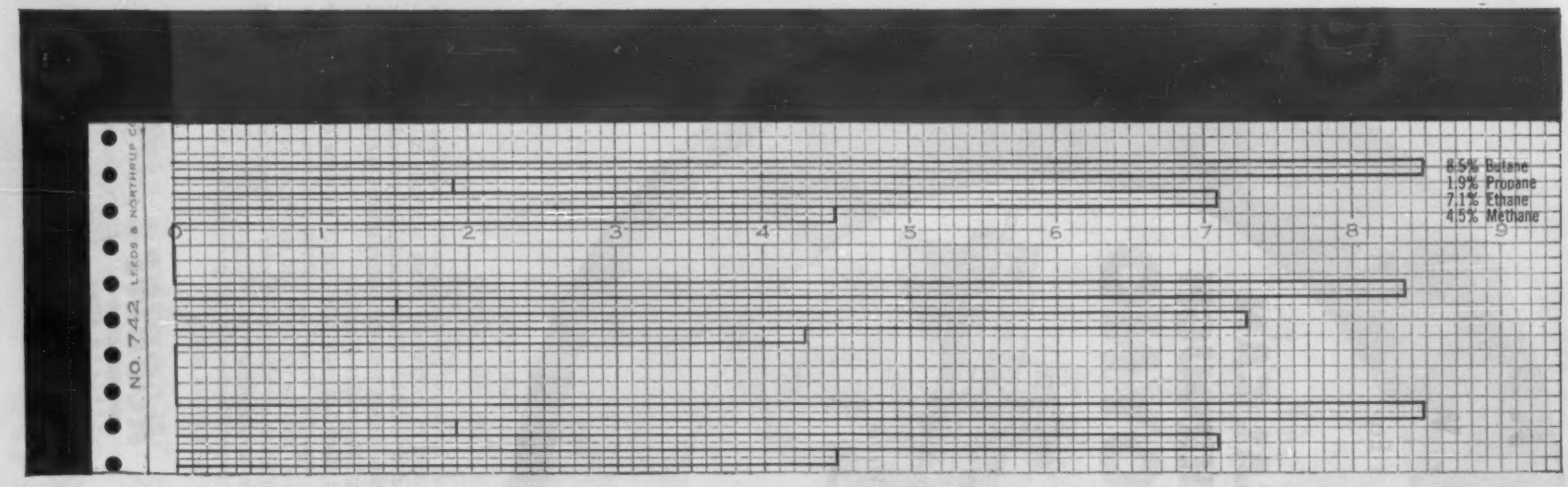
Write for Bulletin 30-CE.

R&M

ROBBINS & MYERS, INC.

SPRINGFIELD, OHIO | BRANTFORD, ONTARIO

MOTORS · FANS · HOISTS · MOYNO PUMPS · PROPELLAIR FANS



Prelude to advanced

process control . . .

New! electronic integration by

CHROMOMAX*

Here is the *first practical electronic integration* of process stream component analyses through Vapor Phase Chromotography. It provides an advanced concept of process monitoring and automatic control. The new "Process-Matched" Integrator, coupled with L&N's versatile Chromomax Analyzer, supplies four fresh facets to this analysis technique.

1. In process stream analysis, component concentrations are presented on a recorder chart in "wide bar display." Each bar height is proportional to the *area* of a particular component peak.

2. Each bar height varies linearly with variations in component concentration. Single-point calibration becomes more meaningful.

3. Two or more adjacent peak areas may be summed to produce an integrated value proportional to a total hydrocarbon concentration.

4. An important link to process control from V.P.C. analyses is established by this integrator. Each component measurement of peak area becomes an electrical quantity which can be used to reset control points through pneumatic or electric transmission. Analysis information can also be supplied to process computers for computations relating to ultimate process control and plant performance.

Start getting the benefits of *tomorrow's* technical advances *today*. Check with your nearest L&N Field Office for application details, or write to Leeds & Northrup Company, 4916 Stenton Ave., Phila. 44, Pa. for data.

LEEDS & NORTHRUP CO

Leeds & Northrup—the leader in Process Chromatography with "Chromomax"

*TRADEMARK

Now "PACKAGED" AUTOMATION of Valve Operation, with LimiTorque

Saves 50% on Equipment & Installation costs

Once again LimiTorque is first . . . LimiTorque valve operators now offer integral mounted NEMA rated reversing controllers, push button and indicating light elements. You can actually reduce the installation and component equipment costs up to 50%.

Various combinations of control items can be included in the same switch compartment. Eliminate costly separate control components when they are obtainable completely wired in your LimiTorque.

To compensate for temperature ranges, overloads are adjustable from 85% to 115% of the heater rating.

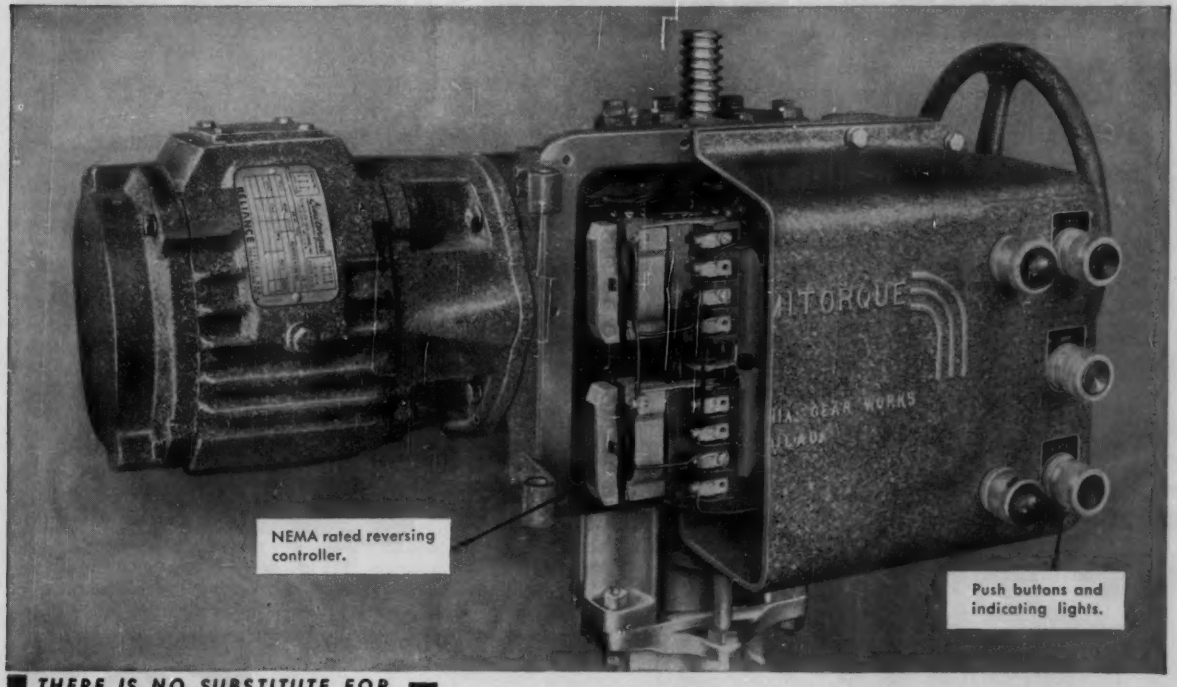
Push button elements, selector switches, etc., when required, are mounted in the hinged cover for quick, easy accessibility to all control components. LimiTorque can be field mounted on your existing valves. Contact your valve manufacturer or closest LimiTorque sales engineering office.

Remember, today's trend is toward low cost simplicity. LimiTorque operators with integral controls are designed with this in mind.

Write for further information.

Minimize use of these costly components!

- Separate push button stations
- Separate reversing controllers
- Control racks
- Conduit runs, conduits
- Enclosures, piping, wiring
- Labor required for above items



THERE IS NO SUBSTITUTE FOR

LimiTorque®

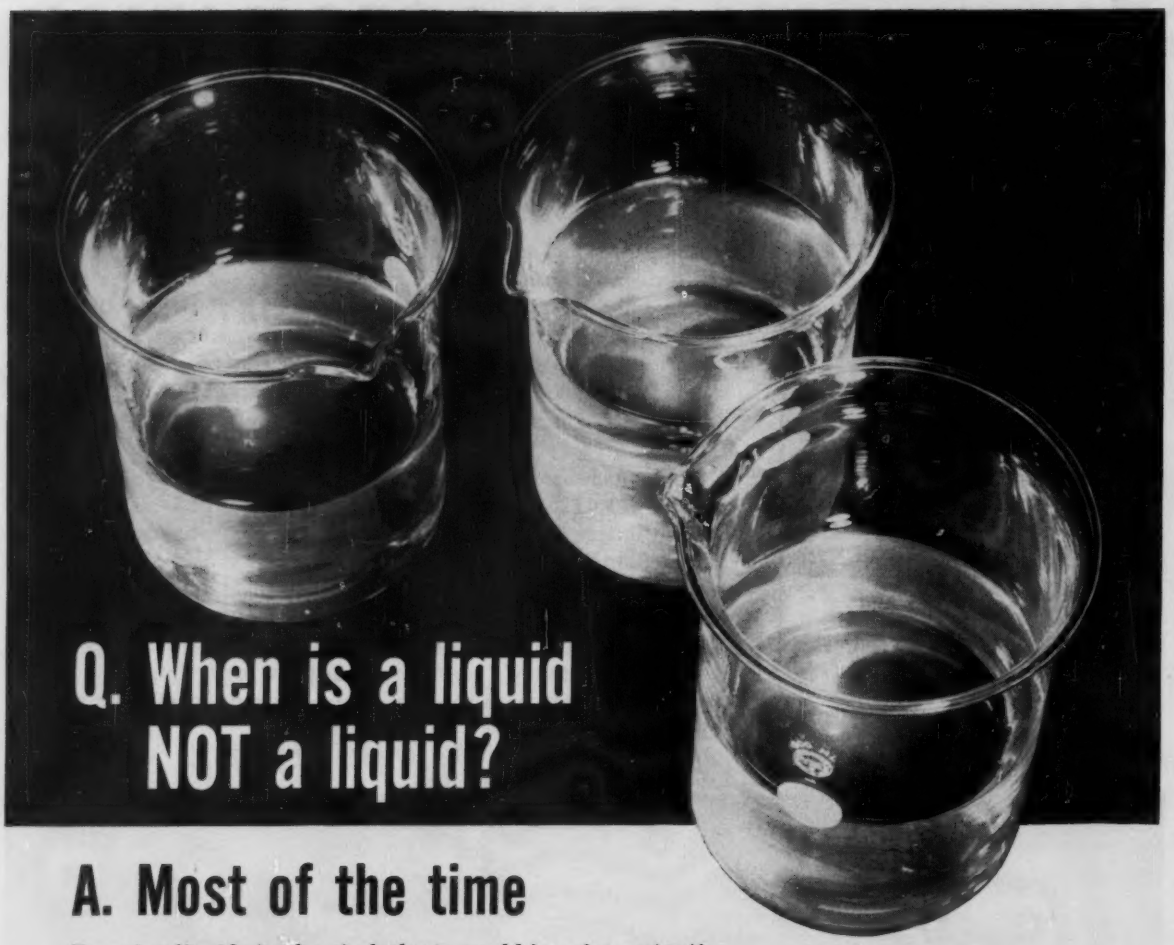
PHILADELPHIA GEAR CORPORATION

ERIE AVE. & G STREET, PHILADELPHIA 34, PENNA.

Offices in all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID AGITATORS • FLEXIBLE COUPLINGS

Limitorque Corporation • Philadelphia



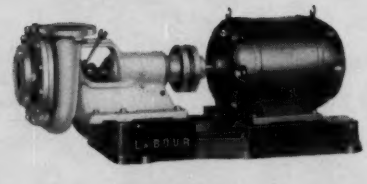
Q. When is a liquid NOT a liquid?

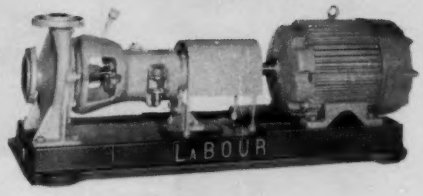
A. Most of the time

Pumping liquids in chemical plants would be a lot easier if you didn't have to pump other things, too. Gases, for instance —vaporized from the liquid by lower absolute pressure on the intake side. Or air, entering through imperfect pipe joints or entrained by an upstream process or condition. Then there are solids—sediment, crystals or just plain dirt, depending on what you are pumping and from where.

Most of the time, in pumping chemicals you've got to deal with one or more of these troublemakers. That's when you need LaBour. Open impellers with generous clearances lick the solid-particles problem. And LaBour design permits handling up to 20% air or gas mixed with the liquid—*in non-priming* pumps.

"The facts of life" must be faced in chemical plants as elsewhere. A thoughtful appraisal of your less-than-ideal situation will save you a lot of future trouble, because you'll have LaBour pumps on the job.





ORIGINAL MANUFACTURERS OF THE SELF PRIMING CENTRIFUGAL PUMP

LABOUR

THE LaBOUR COMPANY, INC. • ELKHART, INDIANA, U. S. A.

"Buffalo" Resin-Bonded Fiber Glass Fume Fan

CORROSION-CONTROL PROBLEMS?

SOLVE THEM WITH THESE SPECIAL "BUFFALO" UNITS

The broad line of "Buffalo" equipment for corrosion control, plus our 80 years of engineering experience in this field, insures you of the most effective solution of your corrosive fume problems.

Whatever your specific needs, you will find the *right* "Buffalo" product with the *right* protective coating and/or corrosion-resistant parts to fill that need.

Contact your nearby "Buffalo" Engineering Representative, or write us outlining your problem. We will be glad to provide you with a prompt, practical, economical solution.

"Buffalo" Type "FG" Fume Fans provide superior chemical resistance to a wide variety of corrosives, including acids, salts, gases, organic materials. Temperature applications range up to 225°F.

The fan housing is formed of resin-bonded fiber glass. All exposed areas of the carefully-balanced steel rotor are encased in thick fiber glass. The "FG" is available in standard capacities up to 34,000 cfm at pressures to 10″ static.

For full details, including chemical resistance table, write for Bulletin FI-511.

"Buffalo" Cast Iron Exhausters, widely-used throughout the chemical process industries, are engineered to operate under the most extreme corrosive conditions.

Husky cast iron housings, plus cast inlet cones with integral inlet vanes, guide air smoothly into the wheels. The result is the low-turbulence air flow inherent in this high-efficiency design. Non-overloading is insured, regardless of system pressure.

Three arrangements are available: direct motor drive, separate belt drive or a package unit with adjustable pitch V-belt drive and motor mounted on adjustable base rails.

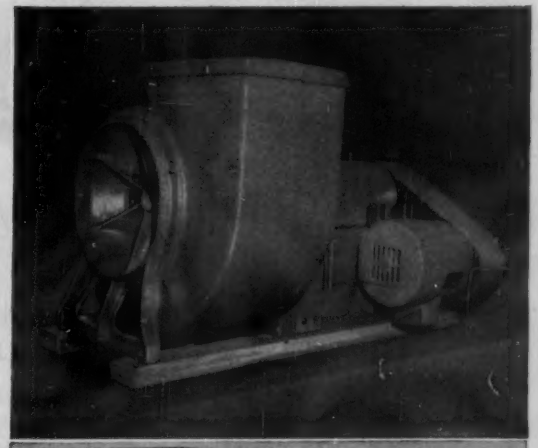
For full information on "Buffalo" Cast Iron Exhausters, contact your nearest "Buffalo" Representative or write us direct.

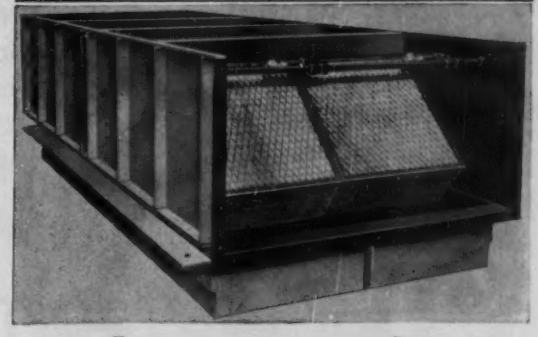
"Buffalo" Gas Absorbers are designed for highly efficient removal and/or recovery of soluble gases, vapors and mists from exhaust systems before discharge to the atmosphere. Absorption is accomplished when the contaminant is completely in solution. This is accomplished by means of an absorbent liquid sprayed on a series of fiber cells.

Field performance tests prove that efficiency of "Buffalo" Gas Absorbers ranges up to 99.8%. Applications fall into two categories: removal of low concentrations from stack gas effluents for prevention of atmospheric pollution, and the absorption of process or off-gases containing sufficient material to make reutilization economically feasible.

Bulletins AP-225 and AP-2500 will guide you to the proper "Buffalo" Gas Absorber to solve your contamination problem. Write for it today.

EVERY "BUFFALO" PRODUCT FEATURES THE "Q" FACTOR — the built-in Quality which provides trouble-free satisfaction and long life.





Top *"Buffalo" Cast Iron Exhauster*

Bottom *"Buffalo" Gas Absorber*

BUFFALO FORGE COMPANY

BUFFALO, N. Y.

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

VENTILATING • AIR CLEANING • AIR TEMPERING • INDUCED DRAFT • EXHAUSTING
FORCED DRAFT • COOLING • HEATING • PRESSURE BLOWING

ACTUAL SIZE

GET THE MOST FOR YOUR

BTU DOLLAR

...with Nicholson steam traps

You get top operating temperature per dollar of fuel consumption . . . when you use the Nicholson steam trap. This trap purges all air and non-condensibles from pipes and equipment *continuously* . . . not just at warm-up time. Your boiler doesn't have to operate at top capacity —all the time—to obtain top steam temperature where and when you need it.

Make full use of your BTU dollar, with Nicholson traps. They have only one moving part . . . a valve that operates on just a few degrees of temperature differential.

In your steam generation, and in your steam utilization . . . Nicholson traps will save you money. You can try one . . . without obligation! W. H. Nicholson and Company, 12 Oregon St., Wilkes-Barre, Pa. Sales and Engineering Offices in 98 principal cities.

NICHOLSON

of Wilkes-Barre

IF YOU'RE just beginning to manufacture alkyd or polyester resins—or an "old-hand" producer with some production problems still unsolved—Pittsburgh's Technical Service Department may be of real service to you.

As a dependable source of phthalic anhydride, maleic anhydride and fumaric acid, we're well experienced—and *ready*—to assist you with your application problems.

This help goes well beyond "samples and data sheet" on our products—which are always available, of course. We'll be glad to make up sample resins, suggest formulations for your special requirements, and recommend sound processing procedures.

And, when the problem calls for it, our engineers are at your service for a trouble-shooting meeting at your plant. Pittsburgh is *not* a commercial resin producer.

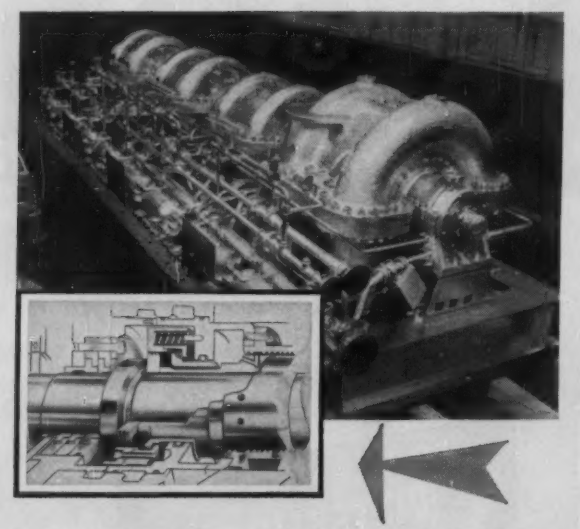
What's your resin production problem? We'd like to help you lick it. *Call or write us the details today.*

COAL CHEMICALS • PLASTICIZERS • PROTECTIVE COATINGS • ACTIVATED CARBON • COKE • CEMENT • PIG IRON

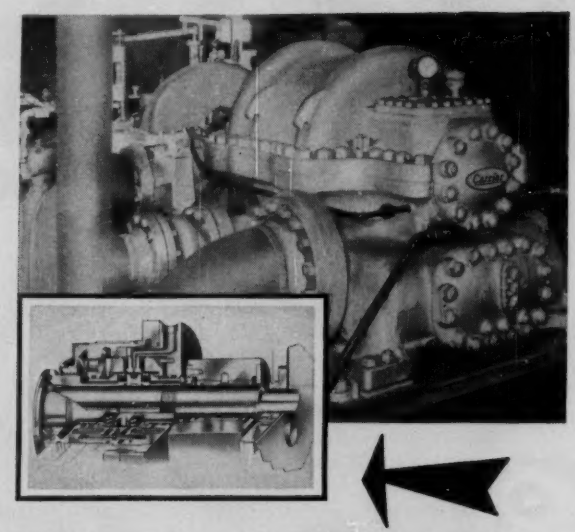
Which is the best way to seal oxygen and hydrocarbon gases?

That depends on the type of gas, its pressure, its toxicity and other factors. No matter what the sealing problem, Carrier Centrifugal Compressors are designed with the right seal for the specific job. For example, an iso-seal is the answer for holding various hydrocarbon gases, especially if the gas must not be contaminated by the sealing fluid or vice versa. At the other extreme, the new Carrier water seal is the correct selection for holding such gases as oxygen where a mixture of oil and the gas cannot be tolerated even in the most minute quantity. For complete information on various compressor seals, call your nearest Carrier office or write Carrier Corporation, Syracuse, New York.

Carrier



To separate the gas stream from the seal oil system, iso-seals are used in each of these four Carrier Centrifugal Compressors which handle ethylene and mixed hydrocarbon gases in an ethylene plant in Baton Rouge. In seals of this type, seal oil, supplied at slightly higher pressure than suction, is kept from the gas stream by a floating carbon ring. The seal oil pressure is then broken down to atmosphere through one or more narrow floating babbitt steel rings; the number depending on the pressure breakdown. On shut-down, this is a positive seal.



Where there can be no chance of contamination between an oil and a gas such as oxygen, Carrier has developed a new mechanical seal using water as a lubricant to seal the gas from suction pressure to atmosphere. With this new type of Carrier water seal, there is no chance for possible leakage of expensive gas. Through efficiency of design, the number of controls and auxiliaries necessary for dependable operation are held to an absolute minimum. There is no explosion hazard with the new Carrier mechanical water seal.

IT'S EC&M FOR A COMPLETE LINE OF SYNCHRONOUS MOTOR STARTERS!

FOR ALL LOW VOLTAGES AND FOR 2200-4800 VOLT POWER SYSTEMS!

Here's Why EC&M Pushbutton Automatic Starters Do The Job Better...

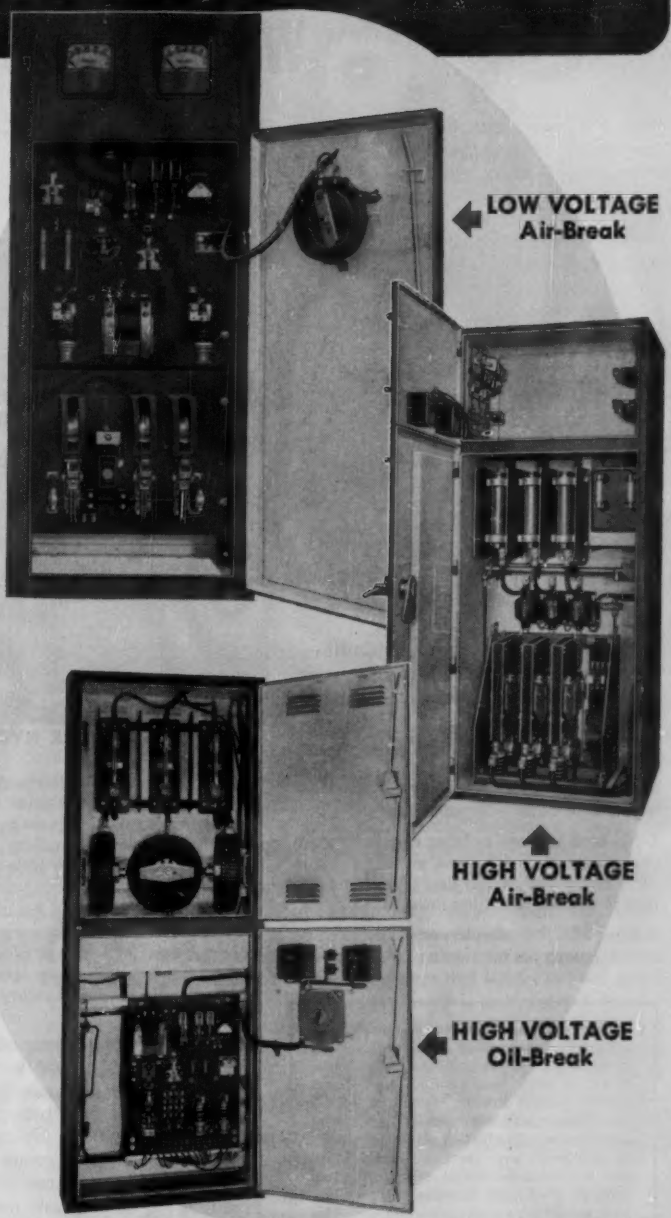
Complete protection during starting, acceleration and while running at synchronous speed.

Motor pulls into step without delay because field is applied under best conditions for synchronization.

Automatic field removal and re-synchronization allow motor to accelerate and re-synchronize after voltage dip or momentary overload.

Easily installed because all internal wiring is complete.

Full or reduced voltage starting All high voltage starters available in 3 ratings: (*1*) 50,000 KVA (certified) interrupting capacity—(*2*) with power-type, current-limiting fuses —(*3*) VALIMITOR® (volt-ampere-limitor), the bus may be of unlimited KVA.



Write for Bulletins 8200 and 8820

THE ELECTRIC CONTROLLER & MFG. CO.
A DIVISION OF THE SQUARE D COMPANY
CLEVELAND 28 • OHIO

8587

Using Salt Efficiently

by INTERNATIONAL SALT COMPANY, INC.

Hydraulic Handling—Quick, Economical Way to Move Salt into Storage

Here's a new, effective method for moving salt from delivery cars or trucks into plant storage, without disrupting other operations. Hydraulic Handling systems, already in operation in several plants, have eliminated the expense of mechanical unloading equipment, and cut down considerably on man-hours needed to do the job.

What is Hydraulic Handling? Very simply, Hydraulic Handling is the movement of granular salt in circulating saturated brine, through pipes. Referring to the diagram, you will note that dry salt from the hopper car is mixed with saturated brine in a salt-receiving pit, to form a slurry of the saturated brine and undissolved salt. This slurry is pumped through a pipe to a salt-storage tank. Overflow brine from the tank continuously returns to the slurrying pit to carry more salt into storage.

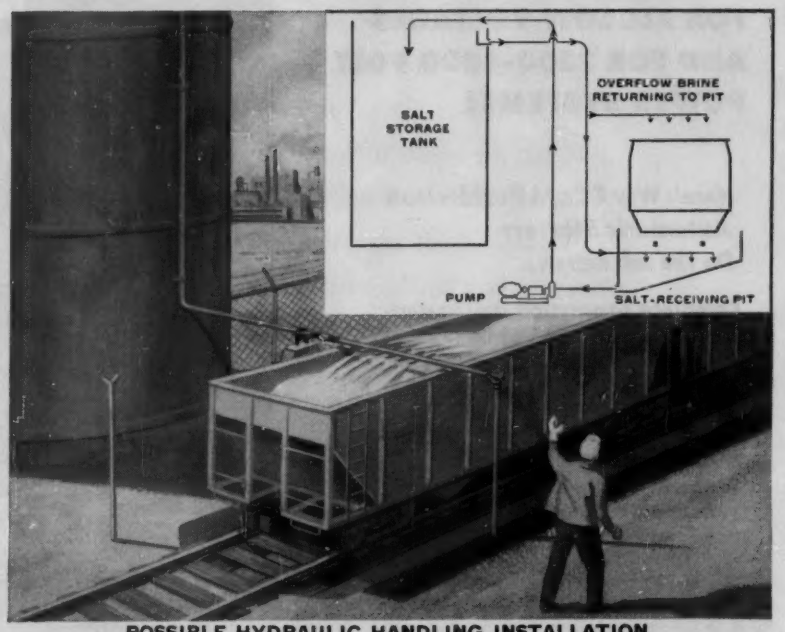
Advantages of Hydraulic Handling. Every Hydraulic Handling installation has a number of exclusive advantages:

1. Great flexibility. Because *pipes* do the work of carrying salt, a Hydraulic Handling system can be installed anywhere in the plant. Piping is flexible, and can be run where it won't interfere with other plant operating activities.

2. No need to move existing equipment. Machines that might obstruct mechanical handling equipment simply don't get in the way of a Hydraulic Handling installation.

3. Long life, low maintenance. You need no safety guards . . . no roofing to protect salt from weather . . . no belt conveyors, elevators or similar pieces of mechanical handling equipment. Also, there is never any salt dust that might corrode vital plant equipment. As a result, Hydraulic Handling installations have a long life, with very little maintenance expense.

4. Unlimited capacity. Hydraulic Handling systems can be designed to unload, move and store any amount and type of salt—rock or evaporated. Whatever your specific unloading needs, Hydraulic Handling can satisfy them.



POSSIBLE HYDRAULIC HANDLING INSTALLATION

For rock-salt users, Hydraulic Handling is especially economical when used with combined wet-storage and dissolving tanks or with International Salt Company's famous Sterling Wet-Storage Lixator. These units store Sterling Rock Salt the same way Hydraulic Handling moves it: combined with saturated brine. Thus the salt-and-brine slurry delivered through Hydraulic Handling to the Lixator *is already in the correct form.* The Lixator delivers 100%-saturated Lixate Brine through pipes to any point of use in the plant, and automatically makes more brine as needed.

From delivery to use, dry rock salt is never handled in plants equipped with both a Hydraulic Handling system and a Sterling Lixator.

You can get more information on how Hydraulic Handling can work in your plant to cut down salt-unloading and salt-handling expense from International Salt Company. One of our experienced Sales Engineers will be glad to work with you to determine the best system of Hydraulic Handling for your specific needs. He can also help you use salt efficiently in *all* your plant operations needing salt or brine.

Behind this qualified salt specialist are all the resources and experience of International Salt Company. We produce both Sterling Rock Salt and Sterling Evaporated Salt in all types and sizes . . . plus automatic equipment for making brine from both kinds of salt. So our sales engineer can recommend the type and size of salt most perfectly suited to your needs. He can also recommend the most efficient and inexpensive methods for storing, handling or using salt or brine. Ask him . . . send a card or letter to International Salt Company, Inc., Scranton 2, Pa. . . . or contact our nearest sales office.

INTERNATIONAL SALT CO., SCRANTON, PA.

Sales Offices: Atlanta, Ga.; Chicago, Ill.; New Orleans, La.; Baltimore, Md.; Boston, Mass.; Detroit, Mich.; St. Louis, Mo.; Newark, N. J.; Buffalo, N. Y.; New York, N. Y.; Cincinnati, O.; Cleveland, O.; Philadelphia, Pa.; Pittsburgh, Pa.; Memphis, Tenn; and Richmond, Va.

Service and Research are the Extras in **STERLING SALT**

PRODUCT OF INTERNATIONAL SALT COMPANY, INC.

How To STOP SLURRY VALVE FAILURE

Rockwell-Nordstrom valve's "clean-as-a-whistle" flow passages eliminate packing by slurries and eventual valve failure from corrosion of exposed seats.

The Problem: Valve failure on green liquor slurry service at a southern paper plant was becoming increasingly costly in terms of lost production time and high maintenance costs. Suspended solids settled out of the solution and packed into the valve cavities . . . soon the valves wouldn't close and corrosive fluids attacked the exposed metal-to-metal seats.

Solution: Comparative performance tests proved that Rockwell-Nordstrom lubricated plug valves eliminated the packing problem and that shut-off remained absolutely positive. The smooth, cavity-free flow passages in these valves can't trap suspended solids. Also, seating surfaces are never exposed to the line . . . positive shut-off is assured by "seals" of pressurized lubricant. The result: quarter-turn, positive flow control plus greatly increased valve life at far lower cost.

Rockwell-Nordstrom valves are available in a full range of sizes, metals and pressures for chemical process services. Write for complete details: Rockwell Manufacturing Company, Pittsburgh 8, Pa. Canadian Valve Licensee: Peacock Brothers Limited.

ROCKWELL-Nordstrom VALVES

it's ROCKWELL

MANUFACTURING COMPANY

Rockwell Manufacturing Company
Pittsburgh 8, Pa.

Please send free booklet V-203 ☐

Please have your sales engineer call ☐

Name_____ Title_____

Address_____

City_____ Zone_____ State_____

This is Why the Nash is the Most Simple Compressor

It's the Nash!

There are no mechanical complications in a Nash Compressor. A single moving element, a round rotor, with shrouded blades, forming a series of buckets, revolves freely in an elliptical casing containing any low viscosity liquid. This liquid, carried with the rotor, follows the elliptical contour of the casing.

The moving liquid therefore recedes from the rotor buckets at the wide part of the ellipse, permitting the buckets to fill with gas from the stationary Inlet Ports. As the casing narrows, the liquid is forced back into the rotor buckets, compressing the gas, and delivering it through the fixed Outlet Ports.

Nash Compressors produce 75 lbs pressure in a single stage, with capacities to 6 million cu. ft. per day in a single structure. Since compression is secured by an entirely different principle, gas pumping problems difficult with ordinary pumps are often handled easily in a Nash.

Nash simplicity means low maintenance cost, with original pump performance constant over long periods Data on these pumps sent immediately on request

- No internal wearing parts.
- No valves, pistons, or vanes.
- No internal lubrication.
- Low maintenance cost.
- Saves floor space.
- Desired delivery temperature automatically maintained.
- Slugs of liquid entering pump will do no harm
- 75 pounds in a single stage.

NASH ENGINEERING COMPANY
313 WILSON, SO. NORWALK, CONN.

Alemite Portable Lubricator Saves 95 Man-Hours For Every Drum of Lubricant Applied!

Every point of lubrication in your plant can cost you needless time and money if you use old-fashioned hand lubrication methods!

With this Alemite portable air-powered lubricator, you save *95 man hours* for every 400-lb. drum of lubricant applied. Over *two* weeks of one man's time saved. That's how you can cut maintenance costs with Alemite.

In addition, Alemite's Model "711-A" is so compact and portable that it can bring clean, waste-free lubrication to *any* machine—*anywhere* in your plant—reducing machine downtime and prolonging machine life. Its pivot-swing dolly holds container upright at any pulling angle for easy moving over rough ground, indoors over rough floors, even up and down steps!

Step up to fast-moving, time-saving lubrication methods! Check Alemite's complete line of air-powered and electric-powered lubrication equipment for industry.

Symbol of SW Excellence

ALEMITE DIVISION
STEWART-WARNER CORPORATION

1850 Diversey Parkway, Chicago 14, Illinois

MAIL COUPON FOR COMPLETE INFORMATION!

Alemite, Dept. J-98
1850 Diversey Parkway, Chicago 14, Illinois

Please send me your free catalog of Alemite industrial lubrication equipment.

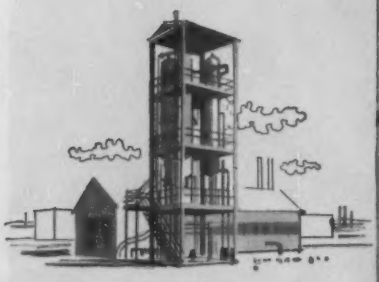
Name .....

Company .....

Address .....

City ..... Zone ..... State .....

Pilot plant reactor shell *after 2000 hours service. Note corrosion on stainless steel shell and flange, while titanium liner shows no corrosion effects. Right: Titanium dip-tube after 2000 hours operation remains free of corrosion damage.*



In high-temperature nitric acid service...

TITANIUM WINS TOUGH 2000-HOUR CORROSION TEST

A large petrochemical company recently tested titanium versus other metals in high-temperature nitric acid service. 6% to 10% concentrations were handled in a pilot plant reactor at temperatures between 300° to 400°F.

Above you see dramatic proof of titanium's performance in this punishing service. After 2000 hours, the reactor's titanium liner and dip-tube showed no corrosion effects, while the stainless steel shell and flanges were badly corroded.

Further corrosion-rate tests were made by immersing test coupons of various metals in the reactor for 40 hours. Again, test results proved titanium's outstanding corrosion resistance (see chart at right).

Want more information? Write for bulletin on Corrosion Resistant Properties of Titanium.

CORROSION RATE TEST
Conditions: 375° F, 300 psig, 6% nitric acid

Material	Corrosion Rate mils/yr
Titanium	nil
347 stainless steel	59
304 stainless steel	170
310 stainless steel	274
410 stainless steel	402
309 stainless steel	485
Nickel-Chrome Alloy	20,500

See our 4-page ad in Chemical Engineering Catalog, Pages 1147-1150, for additional technical information.

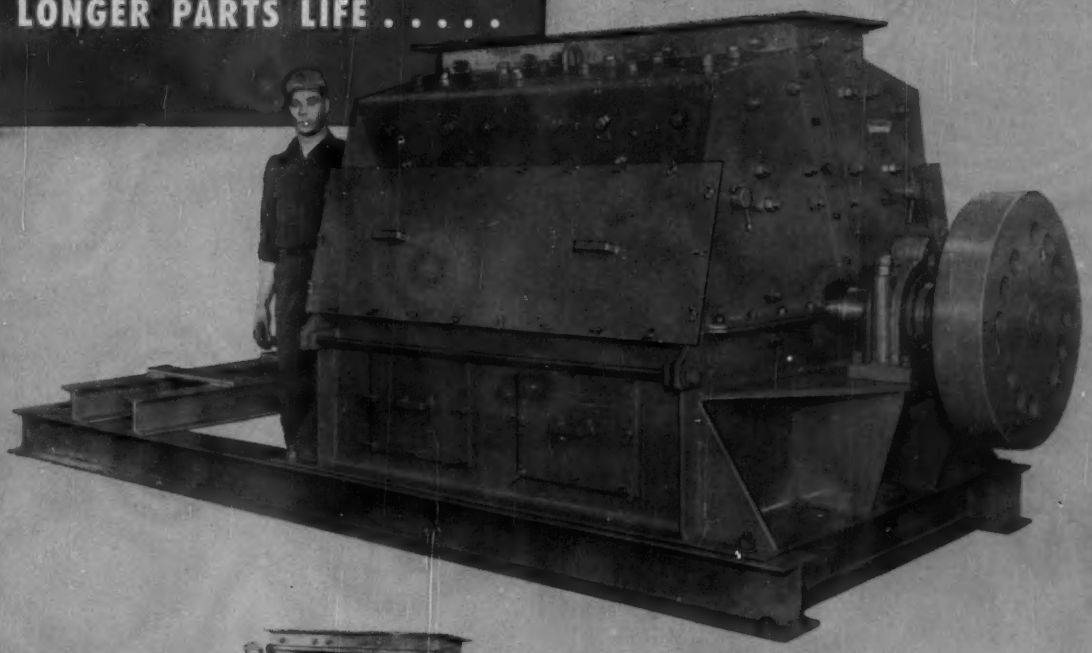
MALLORY SHARON

MALLORY-SHARON METALS CORPORATION · NILES, OHIO

Integrated producer of Titanium • Zirconium • Special Metals

NEW DUAL "2-POINT" ADJUSTMENT INSURES MORE UNIFORM GRINDING, LONGER PARTS LIFE . . . . .

WILLIAMS *Reversible* HAMMER MILLS



Williams Reversible Hammer Mill with cover open.
Note these features:

- Super-strong reinforced steel plate frame
- Renewable wear-resistant manganese steel liners
- Heavy duty oversize forged steel rotor shaft
- Anti-friction self-aligning roller bearings in dust-tight housings
- Complete accessibility to interior for quick parts changing

It's another Williams "first"—features not available in other hammer mills—that now makes it possible to maintain the original close clearances of *both* grinding plates *AND* cage sections against the rotating hammers. This easy-to-make "2-point" adjustment, in the most critical grinding area inside the hammer mill, gives absolute assurance of consistently uniform product quality.

In addition to the advantages of the Dual "2-Point" Adjustment, a Williams Reversible Hammer Mill substantially lowers upkeep expense by cutting hammer cost. Hammers can be operated in one direction today and another tomorrow simply by installing a simple reversing switch on the driving motor. Manual reversing of hammers no longer necessary. Grate bars also last longer. The double set of reversible manganese breaker plates, which last twice as long as other types, give four times the service! Maintenance and downtime are cut 50% or more.

Get all the facts about the hammer mill with *ALL* the top features.

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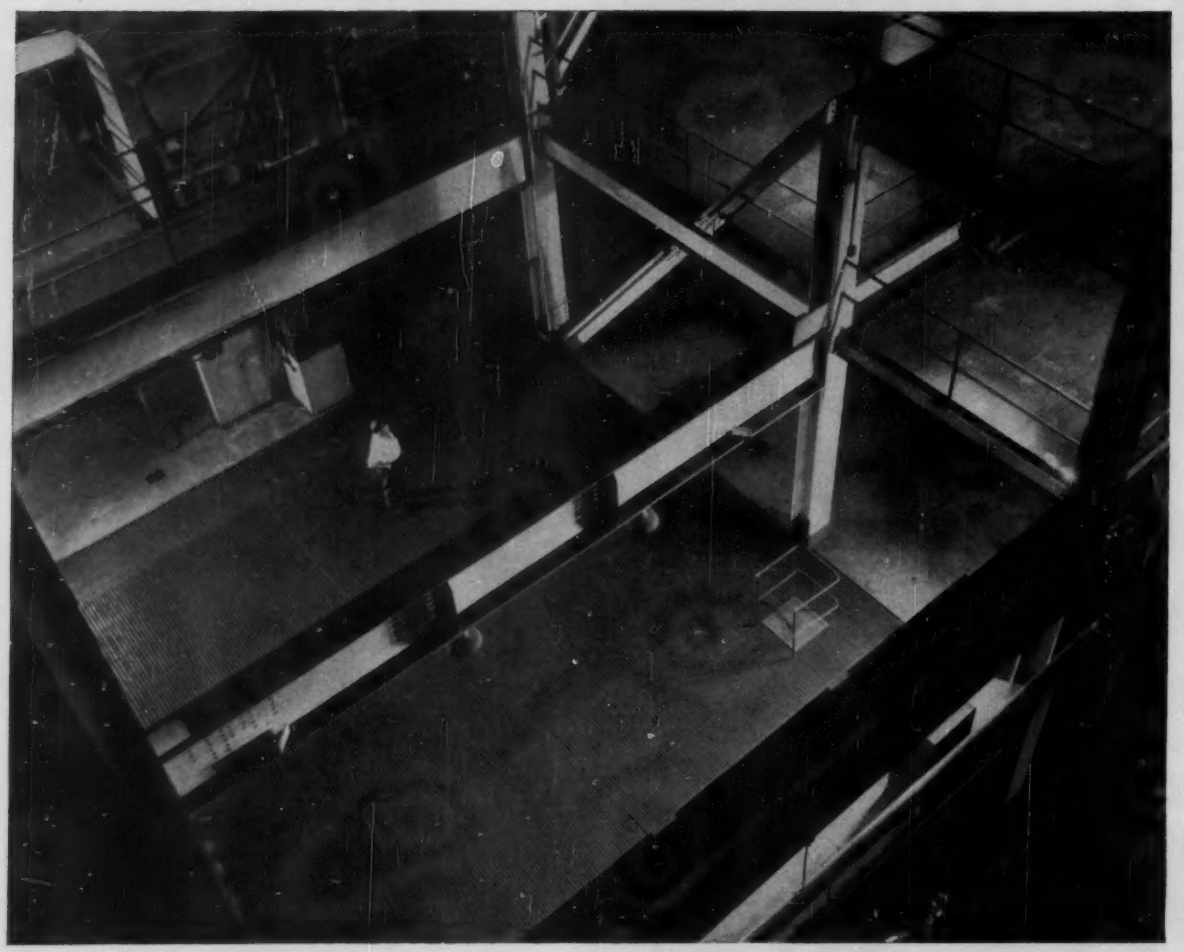
Oldest and Largest Manufacturers of Hammer Mills in the World



Blaw-Knox Electroforged® Steel Grating provides removable floors to simplify plant operation

Floors and mezzanines made of Blaw-Knox grating solve the problem of reaching, moving and servicing the largest types of equipment. Sections come up easily, allowing ample space to maneuver and maintain any size of machinery. Costly, time-consuming alterations are virtually eliminated.

For increased plant safety Blaw-Knox Electroforged Steel Grating provides rigid one-piece construction for sure support of the heavy loads. Non-slip cross bars and a wide variety of bearing bars assure safe walking and climbing — even under the most hazardous working conditions.

Because there's nothing to wear, or patch, nothing to catch and retain dirt, upkeep becomes easy and economical. And grating's maximum open area admits more air and light, makes brighter, better-ventilated plants.

Blaw-Knox Electroforged Steel Grating for walkways, stair treads and floors is fabricated to meet your specific operating needs. For new ideas about a complete line of space saving grating, write for Bulletin 2527 featuring grating and treads.

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BLAW-KNOX COMPANY

Equipment Division
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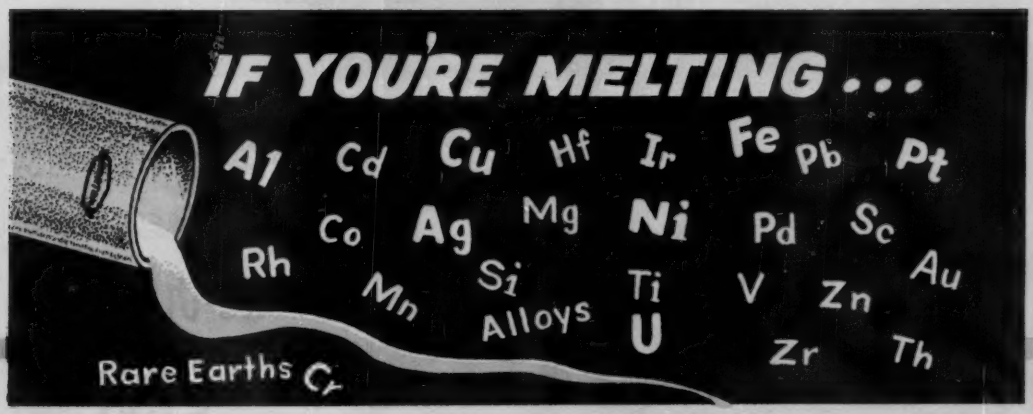

Norton crucibles, available in many materials, meet a wide range of needs

HEAVY WALL CRUCIBLES

Furnace Sizes in Pounds	Outside Diameters	Wall Thicknesses	Over-All Heights
½ to 300	1⅛" to 12¼"	⅛" to ⅝"	3½" to 16½"

Materials Available

ALUNDUM*	"A" 99% Alumina	All Sizes Shown	**ZIRCONIA**	"H" Fused Stabilized Zirconia	All Sizes Shown
CRYSTOLON*	"G" First Quality Silicon Carbide	All Sizes Shown	**THORIA**		½ to 50 lbs.
CRYSTOLON	"N" Nitride Bonded Silicon Carbide	All Sizes Shown	**URANIA**		½ to 50 lbs.
MAGNORITE*	"K" 97% Fused Magnesia	All Sizes Shown			

LIGHT WALL CRUCIBLES

Furnace Sizes In Pounds	Outside Diameters	Wall Thicknesses	Over-All Heights
½ to 50	1 5/32" to 5 13/16"	3/32" to 5/32"	3½" to 10 11/16"

Materials Available

ALUNDUM	"A" 99% Alumina	½ to 50 lbs.	**ZIRCONIA**	"H" Fused Stabilized Zirconia	½ to 50 lbs.
MAGNORITE	"M" 99% Fused Magnesia	½ to 50 lbs.	**THORIA**		½ to 17 lbs.

Norton crucibles are *engineered and prescribed* for a long list of metal melting operations. Available in a wide range of materials, sizes and types — as shown in the tables — they provide long, trouble-free service, protect your product purity and meet specific melting requirements.

Norton heavy wall crucibles, exceptionally strong and dense, are used for most induction furnace melting jobs. Thin wall crucibles, generally of lower porosity, are particularly suited for special and nuclear metallurgical processes. Their fine, smooth surface is particularly valuable for protecting high purity metals from refractory inclusions.

It will pay you to get further facts on this complete line of crucibles. For exact recommendations and all necessary details, contact your Norton Representative. Or write for new catalog, *"Norton Refractory Crucibles,"* to NORTON COMPANY, 509 New Bond Street, Worcester 6, Mass.

*Trade-Marks Reg. U. S. Pat. Off. and Foreign Countries

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No Mystery--
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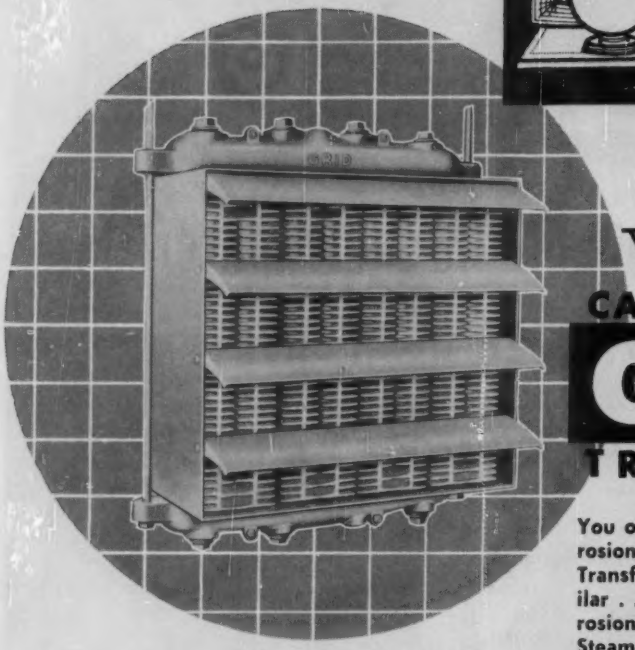
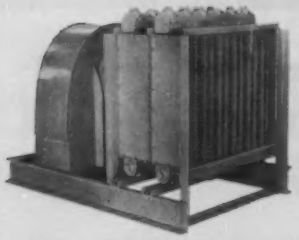
Corrosion
IN HEATING EQUIPMENT
Ends
When You Install
CAST IRON STEAM HEAT
GRID
TRANSFER SURFACE



You once and for all eliminate internal electrolytic corrosion because all metals in GRID Cast Iron Steam Heat Transfer Surface that are in contact with steam are similar . . . not 2 or 3 different metals that promote corrosion to cause leaks and breakdowns. GRID Cast Iron Steam Heat Transfer Surface also eliminates external corrosion because its cast iron construction resists acids or fumes in the air. When corrosion in heat transfer equipment ends, maintenance ends . . . it's as simple as that, no mystery, no magic, no "sales" talk. Your heating problems are no longer problems . . . you do away with high maintenance costs, repair work and the nuisance of leaky heating equipment.

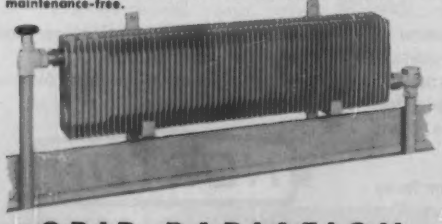
GRID Cast Iron construction eliminates the use of reducing valves where high steam pressures are used. It is designed to withstand steam pressures up to 250 P.S.I. . . . 450° temperature. GRID Cast Iron Steam Heat Transfer Surface does away with replacement costs because GRID is built to last for years . . . operating successfully without maintenance in many plants since 1929. Sounds worth looking into? Then get the complete story today . . . come the heating season you will be glad you did.



GRID BLAST HEATERS

Shown In Fan Assembly

A rugged, strong, and economical heat transfer surface, GRID Blast Heaters are designed for the tough job . . . for low and high steam pressures . . . require less labor for installation, less cubical space, and being designed and made the same as GRID Unit Heaters are resistant to corrosive atmospheres . . . definitely proven for years of service and maintenance-free.



GRID RADIATION

Designed for the tough applications in conjunction with high steam pressure systems, GRID Radiators eliminate the use of pressure reducing valves and because they are built with the same heating sections as GRID Unit Heaters, they will withstand steam pressures up to 250 P.S.I. . . . and wide fin spacing prevents collection of dust and dirt . . . particularly adaptable for factory, shop offices, store rooms, laboratories, etc. . . . any place where smaller heating capacities than required of a unit heater are needed.

29 YEARS MAINTENANCE-FREE SERVICE ON ALL TYPES OF GRID EQUIPMENT

Send for the complete story on GRID Unit Heaters, GRID Blast Heaters, and GRID Radiation for chemical plant use . . . it is contained in GRID Products Catalog No. 956. Write today for your copy.

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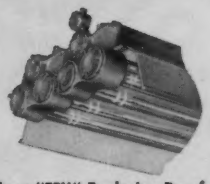

Type "EFU" Explosion-Proof 4-Lamp Fluorescent Lighting Fixture

Type "EFU" Explosion-Proof 2-Lamp Fixture For Horizontal or Angle Mount

Patent No. 2,392,202 and Pat. Pending

CHECK THESE FEATURES

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- 45° or horizontal mounting
- "Rapid Start" ballasts where desired for longer lamp life, no flicker, quiet operation, no starters and long ballast life
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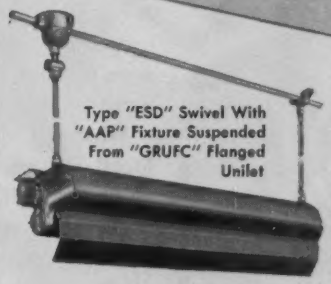

Type "ESD" Swivel With "AAP" Fixture Suspended From "GRUFC" Flanged Unilet

Introduces flexibility in suspension of single unit lighting fixtures in hazardous locations. Meets National Electric Code Article 500.

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APPLETON® Lighting Fixtures are available in non-fluorescent and fluorescent as well as a wide variety of non-explosion-proof and explosion-proof styles. Special shelf, bin and high bay illumination numbers. Write to us stating problem.

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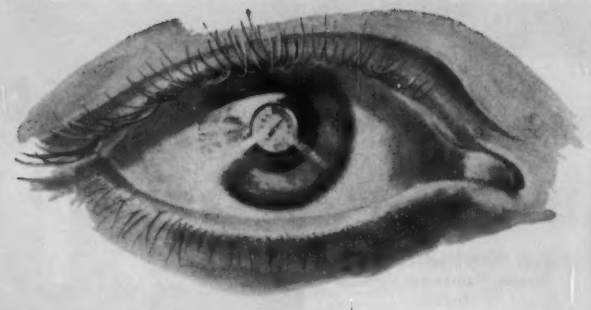

What you read is right

The new, patented Maxivision dial on American Bi-Metal Thermometers eliminates the perspective effect of usual pointer-above-dial construction. No parallax! Readings are sure, sharp and accurate – exact working temperatures are always right before your eyes. It is a two-level dial. A raised outer ring, set close to the cover glass, carries the graduations. The index type pointer is on the same plane as the outer ring, with the numerals on a lower level.

What you read is right when American Bi-Metal Thermometers with anti-parallax Maxivision dial are installed at important check points on your processing facilities. Mounting styles, dial sizes, temperature ranges and stem lengths are available to meet the most exacting requirements. Let your nearby industrial distributor help you select the best combination for each location.

American Bi-Metal Thermometer with Maxivision Dial. Suitable for indoor or outdoor service.

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Ultimately, *somebody* has to get rid of "plant" dust, dirt, smoke and fumes. If the job is left up to workers, the cost to management is exorbitant. For example, if workers' cars are constantly exposed to blankets of dust in the Company parking lot, lowered morale and complaints are the inevitable result.

The modern (and thrifty) way to attack the problem is with AAF Dust Control applied at all dust sources. This way, dust is trapped the instant it is produced. It never has a chance to irritate workers, arouse neighborhood housewives or run up your own plant cleaning costs.

For complete information on AAF's complete line of dust control equipment, write for "The Answers to the Five Basic Dust Problems" (Bulletin 270-A1). Address: Mr. Robert Moore, American Air Filter Co., Inc., 326 Central Ave., Louisville 8, Ky. In Canada: American Air Filter of Canada, Ltd., 400 Stinson Blvd., Montreal 9.

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Corrosion

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It is a sheet of Tygon plastic. Flexible enough you can fold it in your hand. Tough enough to outwear leather many times over. It shrugs off with equal ease — both acids and alkalies.

How is it used? In many ways. In sheet form as a protective lining for tanks containing corrosive chemicals; or as gasketing in critical sealing operations. Far more resistant to chemical attack than rubber, far easier to install, Tygon possesses the unusual property of being neutral, neither affecting nor affected by the vast majority of industrial chemicals.

As tubing—in bores ranging from 1/16″ to 3″—Tygon pipes acids, alkalies, pharmaceuticals, beverages, milk, liquid foods, blood plasma—highly critical and sensitive solutions—in perfect safety. Glass clear, flexible as a piece of string, Tygon Tubing is the standard of research laboratories the world over.

As a liquid Tygon serves both as a paint and as a dip coating. Applied by brush or spray, it protects metals and concrete from attack by acid fumes.

Tygon molds as readily as rubber, and in this form extends its protective qualities over an almost unlimited range of intricate shapes.

If corrosion is a problem to you — Tygon may prove the perfect answer.

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Detailed technical data on the use of Tygon in its various forms, arranged in a convenient reference binder.

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DEVELOPMENTS . . .

SEPTEMBER 22, 1958

Chementator

C. H. CHILTON

Unidentified major chemical company has acquired patents and know-how from Commonwealth Engineering on the Step-Freeze process, is now grooming it for commercial practice. Process dehydrates heat-sensitive materials by removing water as ice crystals.

Stauffer Chemical is negotiating with Mallory-Sharon to buy latter's share in their three-way (with Temescal) electron-beam melting process venture. Move strengthens speculation about Stauffer unifying its high-purity niobium operations.

Humble's new 40-million-lb./yr. polypropylene plant at Baytown, Tex., will operate under Ziegler license. But process is "distinctly superior" to original version by dint of piloting in 1-ton/day unit by Humble and Esso Research & Engineering.

From Geneva, uranium shortcuts

Engineers from Argonne National Laboratory (ANL) outlined before Geneva's just-completed Atoms for Peace conference some noteworthy steps toward simpler, less costly uranium processing.

Both with ore concentrates and spent fuel, ANL engineers have sought shorter routes to refined products. Their plan—cut out several chemical conversion steps associated with solvent extraction techniques. Their method —develop steps for direct conversion of uranium in mixtures to readily separable purified uranium.

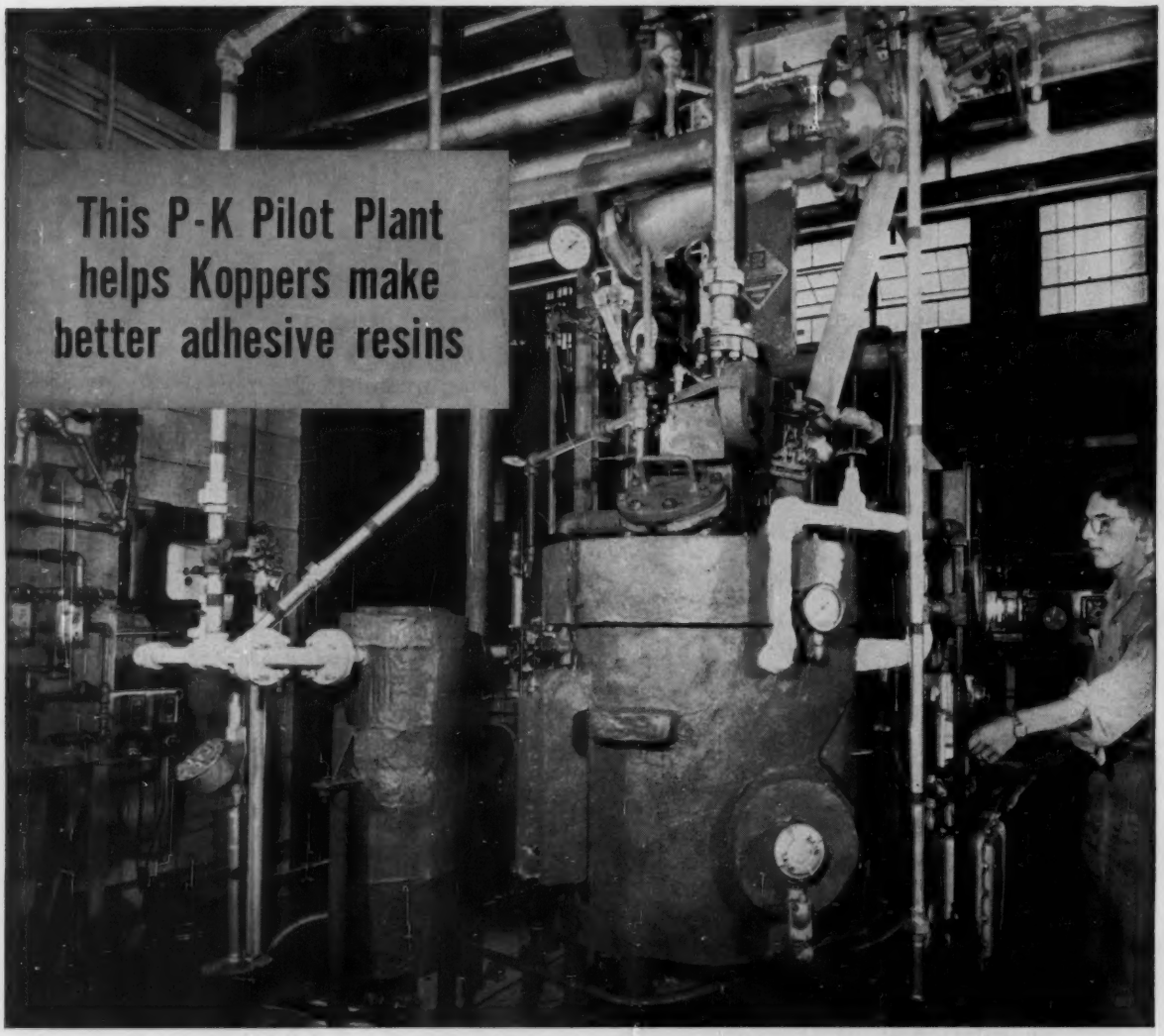
At the now abuilding U. S. uranium refinery, Metropolis, Ill., General Chemical will use three separate fluid-bed operations to produce raw uranium hexafluoride. In order, the U_3O_8 ore concentrate will contact hydrogen, hydrogen fluoride and fluorine. Distillation will purify raw product to refined uranium hexafluoride.

In a similar vein, ANL engineers report piloting of simplified reprocessing schemes for many spent nuclear fuels. Fluorination of the spent fuel forms volatile uranium hexafluoride, as well as non-volatile fluorides of the highly radioactive fission products. Simple distillation separates out uranium hexafluoride containing only 1×10^{-8} parts of fission products.

For metallic fuels, with high uranium content, bromine or chlorine trifluorides react with the fuel to form uranium hexafluoride directly. Fuels with high zirconium content are dissolved in molten fluoride salt by bubbling hydrogen fluoride through salt. Then, follow-up with fluorine gas converts the uranium to hexafluoride which distills away as it forms.

Still to be proven are high-temperature, nonaqueous fuel reprocessing methods scheduled for trial on the Experimental Breeder Reactor II (EBR II) project now under con-

(Continued on page 69)



Technician checks pilot run of new Resorcinol resin at Koppers Verona (Pa.) Research Center. 15-gal. P-K Pilot Plant includes reactor, vapor reflux pipe, condenser, decanter, receiver, controls.

Resins, like many chemical products, are difficult to scale up from laboratory to plant production. Formulas must be painstakingly adjusted until the product of the reaction kettle is identical with that of the laboratory flask.

Koppers solved this problem of scale-up—and a lot of others, too—by installing a P-K Packaged Pilot Plant at its Verona Research Center.

This versatile unit determines production variables on new adhesive resin formulations with a minimum of cost and time. And, because it's a P-K *Packaged* Pilot Plant, Koppers even saved money and time before the unit made its first run — on design, engineering and delivery.

P-K Pilot Plants are made in 5 to 60 gallon capacities. Design can be modified to meet special requirements, and larger sizes can be built.

These units speed *your* product development work in many ways. For example, the smaller plants are ideal for testing and sampling. Larger sizes can even be used for small production runs. In addition to helping you determine scale-up factors from lab to plant, a P-K pilot unit is a tool to find engineering design data for new processes... determine costs... define changes in existing processes to reduce costs... improve quality control procedures.

If there's a new product in your future, get the full story of P-K Packaged Pilot Plants. Just write to The Patterson-Kelley Co., Inc., 1509 Hanson Street, East Stroudsburg, Pa.

14P

Patterson Kelley

Chemical and Process Division

P-K "Twin-Shell" Blenders • Heat Exchangers • Packaged Pilot Plants • P-K Lever-Lock Doors • P-K Vacuum Dryer Blenders

struction near Idaho Falls, Idaho. To date, four processes have attracted much attention:

- Melt refining of spent fuel in zirconium oxide crucible at 2,500 F. for 3-4 hr. to distill off volatile fission products and form slag layer of more stable oxide impurities.
- Extraction of fissionable materials or impurities from molten spent fuel with molten salt or metal solvent.
- Fractional crystallization of uranium-zinc crystals from solution of spent fuel in molten zinc. Separated crystals are heated to drive off zinc.
- Electrodeposition of pure uranium from solution of spent fuel in suitable molten salt.

Henkel terephthalic wins first job

Japan now boasts its own output of terephthalic acid from Kawasaki Kasei Kogyo K. K. in Kawasaki City near Tokyo. And with its plunge into manufacture of this important intermediate, Kawasaki launches first commercial use of the low-cost Henkel process.

Kawasaki's move comes at an opportune time with Japanese imports from the U. S. of TA and TA derivatives up to 3.54-million lb. during the first half of 1958 against 1.3-million-lb. total for all of 1957. Starting with a 15 ton/mo. pilot plant in May 1957 (*Chementator*, Jan. 13, 1958, p. 77), Kawasaki has now hit a 210 ton/mo. pace, is aiming for 400-ton/mo. output by April 1959. Even though Kawasaki's growth seems to match the upsurge in TA usage, it will lag demand enough so that U. S. sellers will still have a market there for some time to come.

Kawasaki's choice of the Henkel process was influenced strongly by significant cost savings obtained by recovery and recycle of potassium hydroxide.

Either phthalic anhydride or benzoic acid, obtained locally, are starting materials for the process. Potassium orthophthalate, derived from the former, isomerizes to the terephthalate, usually at 792 F. with zinc or cadmium salt catalyst. If starting material is benzoic acid, benzene forms during the reaction and must be separated from the terephthalate.

After isomerization (yields over 95%), catalyst is filtered from water solution of terephthalate. Treatment with hydrochloric or benzoic acid yields crude TA and frees potassium which is removed as hydroxide for recycle back to salt-forming step. Final purification takes place over activated carbon.

Rosin maker finds pellet answer

A new, low-cost, compact way to pelletize rosin appears headed for broader use on other low-softening-point solids now handled by prilling or other means. Now operating at 2,500 lb./hr. rate at G&A Laboratories, Savannah, Ga., process produces pellets that remain free-flowing under normal storage conditions.

Battelle Memorial Institute developed process for G&A's modified rosin to overcome problems encountered by customers in reducing large lumps of rosin to usable small pieces. Battelle's success lies in ability to turn out rosin particles sufficiently small to be free-flowing and sufficiently non-adhering so that they will not stick together in a solid mass when stored.

That Battelle could achieve this result with relatively simple, compact equipment provides powerful stimulus for broader use. At G&A, a feeding device discharges the molten droplets into mechanically expanded bed of inert powder. Droplets give up heat to powder and solidify into pellets coated with powder film which prevents reagglomeration.

Stream of powder and pellets discharging continuously from powder bed goes over screen for separation of pellets which are cooled further and bagged. Powder goes through cooler and back to expanded bed.

Ultimately, G&A fully expects to offer its pelletizing process for license to interested parties. Patent applications have been filed to cover the development.

Fluid bed updates ancient desulfurizer

Modern technology applied to use of iron oxide for desulfurizing gas now raises this time-honored method up to present-day performance levels.

Using two tandem fluid beds of iron oxide particles at 660 F., Britain's Appleby-Frodingham Steel Co. removes better than 99.9% of the H_2S and organic sulfur in coke-oven gas. Recovered sulfur can be used for manufacturing sulfuric acid.

At operating equilibrium, heat generated within system completely satisfies process heat

(Continued on page 72)

MEXICO'S FIRST TRIPLE SUPERPHOSPHATE PLANT

another fertilizer project

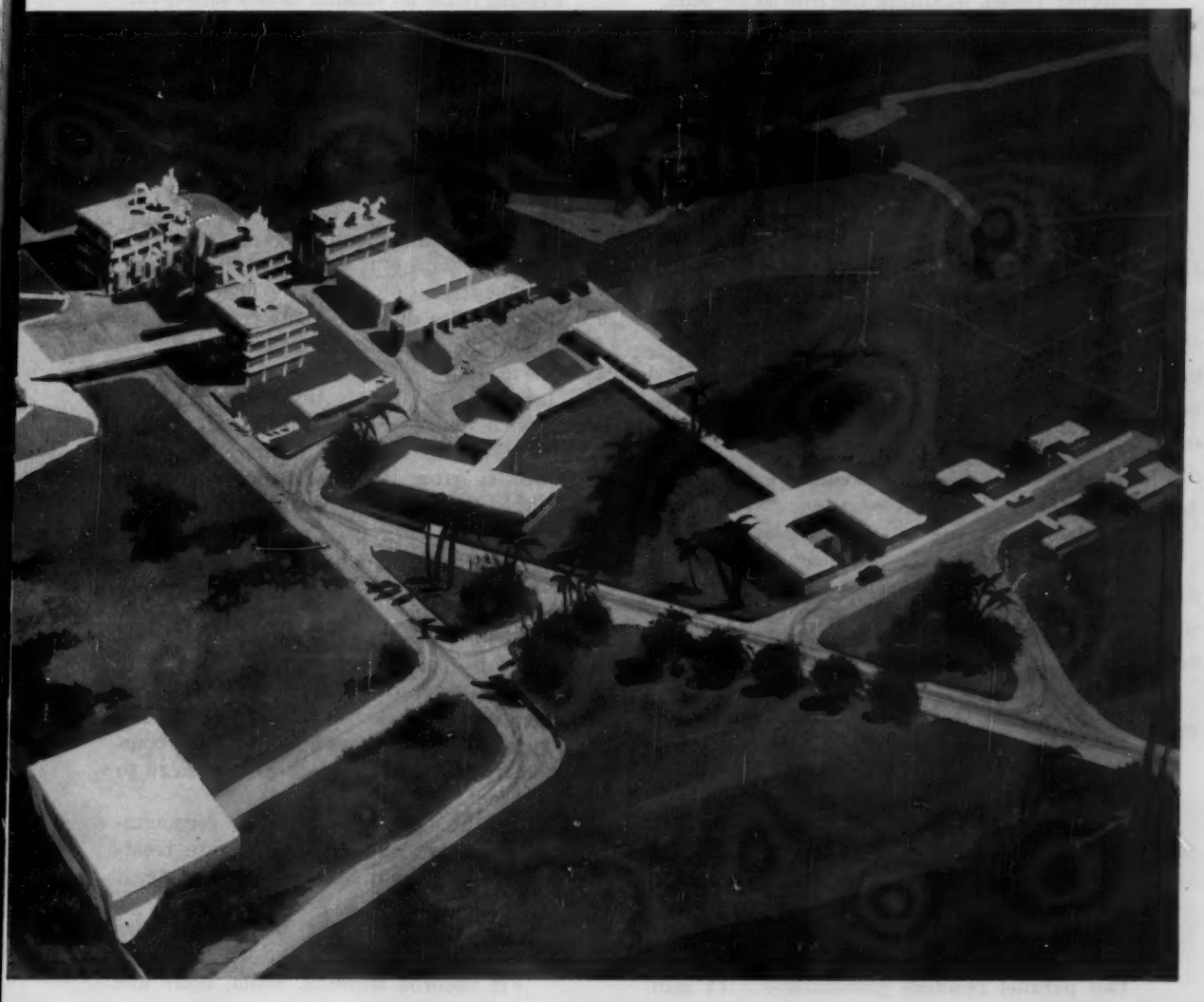
designed and equipped

by DORR-OLIVER

Designed to produce 150 metric tons per day of granular fertilizer, the projected plant shown here is part of a Mexican government program to promote agriculture and increase industrial independence. It will be the latest of several chemical and fertiiizer operations of Guanos y Fertilizantes de Mexico, S. A., and the first Mexican plant producing triple superphosphates. Start-up is scheduled for 1960.

Like so many of the most modern fertilizer plants erected throughout the world, this new venture will employ the Dorrco Granular Fertilizer and Dorrco Strong Phosphoric Acid Processes. Plant design, engineering and equipment for these processes are being supplied by Dorr-Oliver Incorporated. The contract with Dorr-Oliver also calls for design, engineering and supply of equipment for unloading and storage of raw materials, shipping, power production, warehouse, laboratory, offices and other buildings.

Modern layout of the Guanos y Fertilizantes de Mexico plant is suggested in the artist's visualization above. Design is planned to permit doubling of production facilities at a later date. The location of the plant will be near Coatzacoalcos, Veracruz. Phosphate rock will be imported from Florida.



The services of Dorr-Oliver cover all phases of fertilizer plant design, from laboratory studies and economic evaluation to supplying a complete operating facility of any size. Write for a copy of Bulletin No. 8000 — or let us send an engineer to discuss your particular project. No obligation, of course.

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requirements. Sulfur-laden gas (approx. 1% H_2S, 1% organic sulfur) enters process through exchangers where desulfurized gas preheats it to 500 F. From the preheater, gas flows into absorber vessel, fluidizing the iron oxide beds.

Heat introduced by hot oxide recycling from the regenerator raises operating temperature of the absorber to 660 F. At this temperature, iron oxide absorbs H_2S very rapidly. And the hot oxide apparently catalyzes conversion of organic sulfur to more H_2S.

Oxide flows continuously from bottom absorber bed to regenerator where fluidizing air oxidizes sulfur to SO_2 and some SO_3 at operating temperature of 1,110-1,470 F. Being dry and free from arsenic, chlorides and nitrogen oxides, gas makes good feed for contact sulfuric acid plant. Regenerated iron oxide returns to top bed in absorber.

After operating a 2½-million-cu.-ft./day pilot unit for more than 2 yr., Appleby-Frodingham now is constructing a 32-million-cu.-ft./day plant due on stream in mid-1959. Capital cost will compare favorably with other methods; operating costs will be lower.

Desulfurized gas will heat open-hearth steel furnaces. An associated facility will use the regenerator offgas to produce 250 tons/wk. of sulfuric acid.

Steel-mill wastes nourish ammonia plant

Waste coke-oven and blast furnace gases from a steel plant are the sources of nitrogen and hydrogen for ammonia synthesis at Huettewerke Salzgitter A. G., Brunswick, West Germany. On stream since Sept. 1956, the 161-ton plant is considered unique in Europe, has no counterpart in the U. S.

Coke-oven gas containing 60% H_2, 24% CH_4 and 6% CO feeds alternately to one of two parallel reactors preheated for 11 min. to 2,640 F. by combustion of blast furnace gas. During 5-min. on-stream cycle, reactor cracks the gas and reforms it with steam to yield a gas composition of 77% H_2, 15% CO and 0.7% CH_4.

Second stage in preparation of synthesis gas introduces nitrogen and boosts hydrogen level. Cracked, reformed gas from first stage mixes with steam and another stream of blast furnace gas composed of 31% CO, 10% CO_2, 1.2% H_2 and nitrogen. By shift conversion of CO and H_2O to CO_2 and H_2, mixed stream ends up with analysis of 20.5% CO_2, 3.5% CO, 56.7% H_2 and the balance N_2.

Washing of gas by Uhde system removes CO_2 and recycles CO to shift converter. Then, synthesis gas goes to conventional catalytic ammonia process.

Process material balance shows 49,000 cu. ft. of coke-oven gas and 35,000 cu. ft. of blast furnace gas to produce 1 ton of ammonia. An additional 84,000 cu. ft. of blast furnace gas is burned to heat the reactors. Total plant investment is $112/ton of annual capacity.

Waste sludge blunts effluent toxicity

Next best thing to having no industrial waste to cope with is to use one waste stream to pull the teeth of another. That is how Eli Lilly handles complex waste from its new $5-million fine organic chemicals plant at Lafayette, Ind.

Lilly hits the highly toxic raw chemical waste with sludge produced during treatment of antibiotic waste. New composite sludge that settles after this intermingling can be discharged to sealed lagoons for drying; overflow is suitable for feed to the plant which treats the antibiotic waste.

Lilly's chemical effluent is certainly a perplexing mixture. It has a pH below 1, BOD of 500,000 ppm., 30-50% dissolved solids (fatty acids and esters) and an odor. It is turbid, dark colored and at times contains as much as 90% organic solvent. It's too smelly and corrosive to burn economically, too complex to fractionate, too toxic to discharge to environment.

When anaerobically digested fermentation sludge from the antibiotic-waste treatment plant mixes with the chemical waste, it does three things:

- Being alkaline, it helps neutralize acidity.
- It absorbs solvents, scum, color and lessens odor.
- It helps coagulate the mixture rapidly.

Sludge settles rapidly after mixing, carrying down 90-95% of organic matter within 30 min. to produce 50% by volume supernatant liquor. Only other aid to coagulation may be the lime added for neutralization, amounting to 5% of total effluent weight.

Operating tricks (patent applied for) include: optimum ratio of sludge to chemical waste, concurrent addition rates of lime and sludge to chemical waste, degree of agitation.

For more on DEVELOPMENTS.....74

TO STEP UP EFFICIENCY OF SULFONATIONS, SULFATIONS

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(stabilized sulfuric anhydride)

Step up sulfonation efficiency. "Sulfan" has 99.5% SO_3 available for sulfonation reactions. For many applications, "Sulfan" offers nine times as much usable SO_3 as 100% sulfuric acid . . . over three times as much as 20% oleum. This can mean a considerable saving in operating costs.

Step up processing efficiency. With "Sulfan," there is no waste acid. This means that you can increase batch sizes or get more rapid through-put . . . often double without increasing size of equipment! Since no water is formed when "Sulfan" is used for sulfonation, the waste acid problem inherent with use of sulfuric acid or oleum is eliminated.

These benefits alone make "Sulfan" worth your thorough investigation. You may be able to realize other important process economies and advantages too.

"Sulfan" is readily available in tank cars and 750-lb. drums.

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GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N. Y.

FIRST step toward nerve gas reacts phosphorus with chlorine to produce phosphorus trichloride.

Army Permits Peek at Nerve Gas Facilities

Starting with chlorine and phosphorus at Muscle Shoals, the Chemical Corps produces an intermediate which it converts to nerve gas at Rocky Mountain Arsenal.

How well chemical engineers helped the U. S. close a gap in its defenses is indicated by pictures and description of nerve gas manufacture just released by the Chemical Corps, U. S. Army.

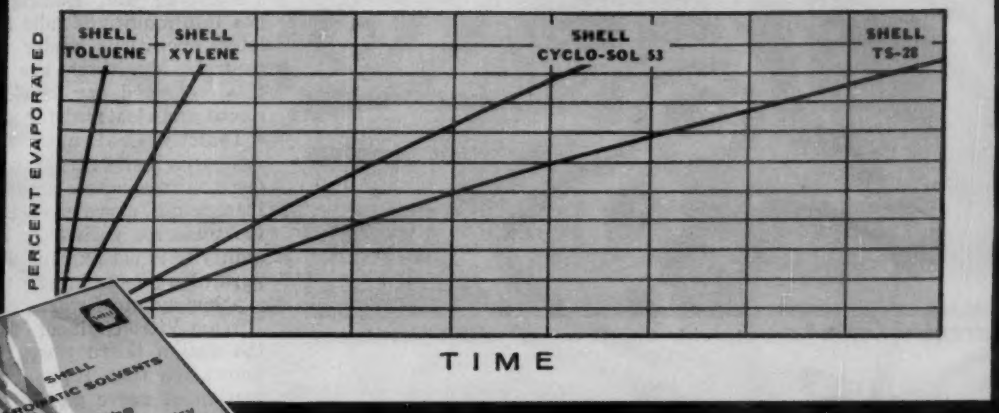
Starting in 1950, Vitro Engineering Co., a division of Vitro Corp. of America, designed and built for the nation a $90 million plant for production of highly toxic alkyl fluorophosphonates, basic constituents of nerve gas. Within three years, the huge complex of specialized chemical-plant equipment was running as an integrated unit on the hazard-studded process.

Vitro's description of the process, now declassified by the Army Chemical Corps, and information published by English researchers McCombie and Saunders (*Nature*, Vol. 157, pp. 287-289) are the bases for the following rundown on the process.

▶ **Starts at Muscle Shoals**—Because the ultimate storage site for nerve gas munitions is Rocky Mountain Arsenal, near Denver, the Chemical Corps first manufactures an intermediate at Muscle Shoals, Ala., source of phosphorus and chlorine raw materials. Then, the intermediate goes to Rocky Mountain Arsenal for processing into nerve gas munitions and final storage by the Chemical Corps.

At Muscle Shoals, process starts with reaction of phosphorus and chlorine to produce phosphorus trichloride. Then, the PCl_3 is esterified with methyl alcohol; methyl phosphonate formed is chlorinated with phosphorus pentachloride to yield a methyl chlorophosphonate.

For industrial finish formulation...



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with a variety of evaporation rates

Typical properties are given in the booklet shown. Write for a copy.

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. . . for applications where very fast evaporation and high solvency are required.

SHELL XYLENE

. . . has an exceptionally narrow distillation range, is slower drying than toluene.

SHELL CYCLO-SOL* 53

. . . an excellent solvent with higher flash point and slower evaporation rate than xylene. Recommended for baking finishes and flow coating.

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SHELL TS-28 SOLVENT

. . . a still slower drying aromatic concentrate of medium high solvency. Recommended for baking finishes and flow coating.

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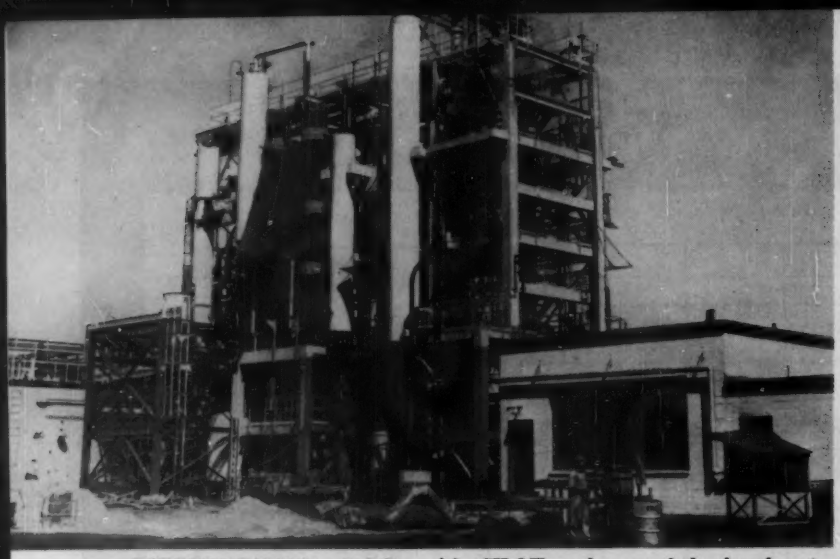


ESTERIFICATION of PCl_3 with CH_3OH makes methyl phosphonate.

JUST RELEASED

Phosphorus oxychloride byproduct goes through a supporting facility for reduction and recycle.

Other supporting facilities recover methanol and byproduct methyl chloride, methyl ether and hydrogen chloride from the esterification or chlorination steps. Purification steps such as distillation of methyl chlorophosphonate and salting-out evaporation are included too.

Methyl chlorophosphonate undergoes fluorination with a suitable agent such as sodium fluoride to replace the chlorine in the molecule. Subsequent separation steps isolate the toxic methyl fluorophosphonate. Among the supporting facilities are a hydrogen fluoride recovery unit and a large refrigeration setup to provide process coolant.

Blending and loading nerve gas into munitions calls for isolated operations under remote control. Munitions are tested, filled, checked for level, fused closed and clustered for storage.

▶ **Toxicity Challenged Designers**—Originally struck upon by German researchers seeking new insecticides, nerve gas was found too toxic for such use. But its ability to affect humans much as parathion affects insects made it a prime agent of warfare.

What Vitro engineers faced on the design board was the sure knowledge that ½ ppm. concentration of nerve gas in the air can destroy control of bodily functions, produce convulsions and sure death within 10 min. Action is attributed to inhibition of choline esterase's catalytic function in the body which allows choline acetyl to build up and poison the system.

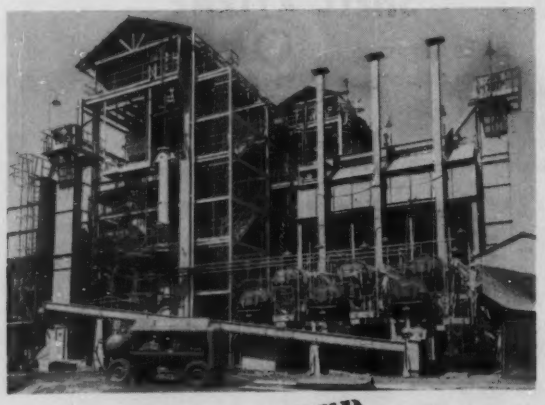
To isolate the nerve gas completely from any possible contact with humans, Vitro installed the final process steps inside a dense-concrete building maintained below atmospheric pressure. Air can flow only from the outside in, never from the inside out. Only possible way for air to flow out of the building is through a neutralizing unit and then out a 200-ft. stack.

▶ **Countermeasures**—Elaborate alarm systems report intolerable concentration of nerve gas, should it occur. Backing up these specially designed "microsensors," strategically located rabbits and canaries do sentry duty against intrusion of nerve gas.

While extensive controls minimize need for personnel to enter process areas, there is need for occasional visits. To protect personnel against accidental exposure during such visits, any person entering one of these areas carries a hypodermic needle and atropine sulfate antidote for emergency use.

▶ **Equipment Needs Protection, Too**—Process steps involving use of chlorine, chloro and fluoro

JUST RELEASED

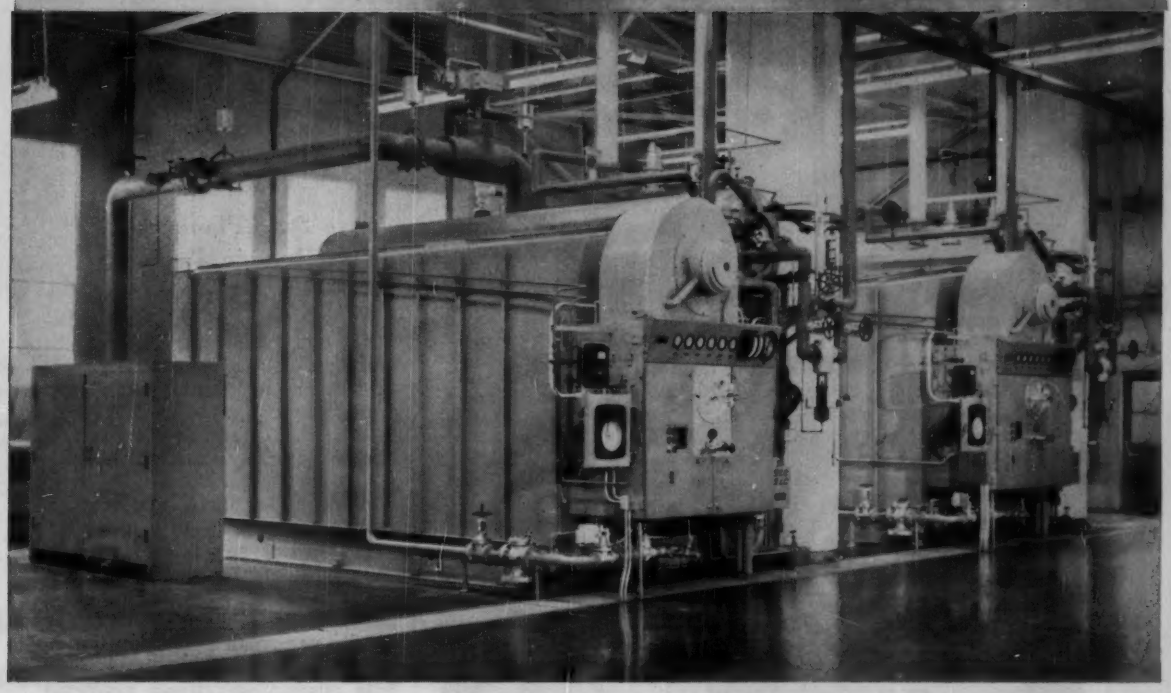


REDUCTION of byproduct $POCl_3$ produces phosphorus recycle stream.

JUST RELEASED

FINAL conversion of intermediate to nerve gas takes place in leakproof structure.

PACKAGED STEAM
by Foster Wheeler
at BOEING DEVELOPMENT CENTER



Two 34,000 lb/hr Packaged Steam Generators supply heating and process load at aircraft and missile research center

In the boiler room at Boeing Aircraft Company's new development center in Seattle, Washington, the two Foster Wheeler AG-134 Packaged Steam Generators shown above provide ample capacity for both present and future loads.

Each unit has a guaranteed rating of 34,000 lb/hr at 250 lb design pressure and 150 lb working pressure with oil firing. When firing natural gas, the output is 32,000 lb/hr.

Shipped completely assembled from Foster Wheeler's Dansville, N. Y. plant, they were installed on simple slab foundations. Each unit is equipped with semi-automatic combustion controls and a 44-inch self-supporting stack. The 36-inch steam drum includes a baffled steam collector, piping for feedwater distribution, continuous and surface blowoff. Staggered boiler bank tubes and closely spaced waterwall tubes contribute to high efficiency while large furnace volume provides conservative rates of heat liberation.

FW Packaged Steam Generators are now available in capacities from 10,000 to more than 60,000 pounds per hour. For complete information, write to *Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, N. Y.*

FOSTER WHEELER

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compounds produce highly corrosive conditions. To prevent destruction of process equipment operating under such conditions, Vitro made wide use of Monel, Hastelloy, Karbate, stainless steel, tantalum and silver. And special methods of fabrication were developed to permit most effective use of these materials.

Nuclear Fuels, Ceramics Get a Plant and Patents

Two recent developments underscore the growing importance of ceramics in the nuclear age.

Patent awarded to Vitro Corp. of America covers a process for making ceramic-clad metal structures via electropheretic deposition and bonding of ceramic to metal. Interposed coatings of metal and ceramic are made by establishing electrostatic field between two electrodes immersed in colloidal dispersion of charged particles. Suspended particles migrate to one of the electrodes.

Too, mixtures of metallic oxides and ceramics can be codeposited by this method, and then sintered in a reducing atmosphere to form tough metal surfaces.

American Lava, plant includes tanooga, Tenn., has now completed a plant to make ceramic nuclear fuel elements of uraniathoria mixtures. According to American Lava, plant includes the most modern fabricating equipment and safety facilities. Plant can produce fuel pellets ranging from ¼-in. to 1-in. dia.

More Efficient Cr Route; Case for Chemical Sleuth

Sharp boost in current efficiency for electrolytic laboratory production of high-purity (99.9 + %) ductile chromium has now been reported by U. S. Bureau of Mines, Albany, Ore.

Significance of work, adds BuMines, is that this process offers possible economic advantages over conventional hydrogen-reduction route to high-purity chromium. However, BuMines is unable to offer an explanation of mechanism that increases current efficiency using the new route.

By adding hydrofluosilicic acid (H_2SiF_6) as complexing agent to the chrome acid bath, BuMines boosted current efficiency from 12-13% to 44%. In previous experiments, it had used sulfate ion from sulfuric acid.

BuMines says it won't conduct further research on process, but will turn over data to interested industrial firms.

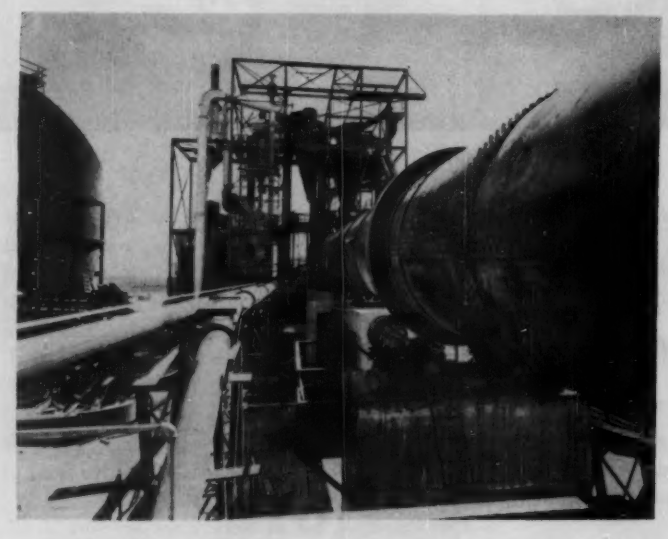
Five-Year Planners Eye Russian Fuels

Russian government planners hope for greatly expanded natural fuel processing facilities in the next 10-15 years. Both petroleum and natural gas figure in their expansion programs.

By 1973, the Soviets want 50 new oil refineries, most of which are to have about 115,000-bbl./day capacity for a total new operating capacity of 5.5 million bbl./day. The planned rate of growth over current estimated USSR refining capacity of 1.8 million bbl./day is a whopping 9% per year. In comparison, U. S. operating capacity growth is now conservatively predicted at 2.5% per year from the current 9.2 million bbl./day.

▶ **Natural Gas, Too**—Increased Soviet chemical industry activity poses the problem of supplying sufficient natural gas to meet production requirements. Planned for annual production in 1965: 350 billion cu. yd. of natural gas, while 4 million tons of LPG are to be produced (as compared to current 60,000 tons). Research and development seek improved methods for chemical processing of natural gas and chemical use of raw material gas condensates.

Transportation of the fuels is included in expansion plans. By 1965, 16,000 miles of major pipelines are expected to carry gas to important USSR industrial regions. *Soviet Weekly* also recently reported an 800-mile-long pipeline is under construction at Polotsk to carry oil from the Volga area to a new refinery in Byelorussia.



Towards Purer Products: Filter Aid Plant Starts Up

Partial view of Eagle-Picher's new $2.5-million filter aid plant at Lovelock, Nev., shows large rotary kiln in right foreground. Plant, marking firm's entry into filter aid market, caps long search for suitable diatomaceous earth deposit.

CORROSION RESISTANT

2-way valves (requiring separate source operating pressure)

All of these basic types of valve operation are available from ASCO.

2-way valves fully automatic (do not require separate source operating pressure)

2-way and 3-way Manual Reset

3-way Fully Automatic

ASCO offers a complete selection of corrosion-resistant 2 and 3-way solenoid valves

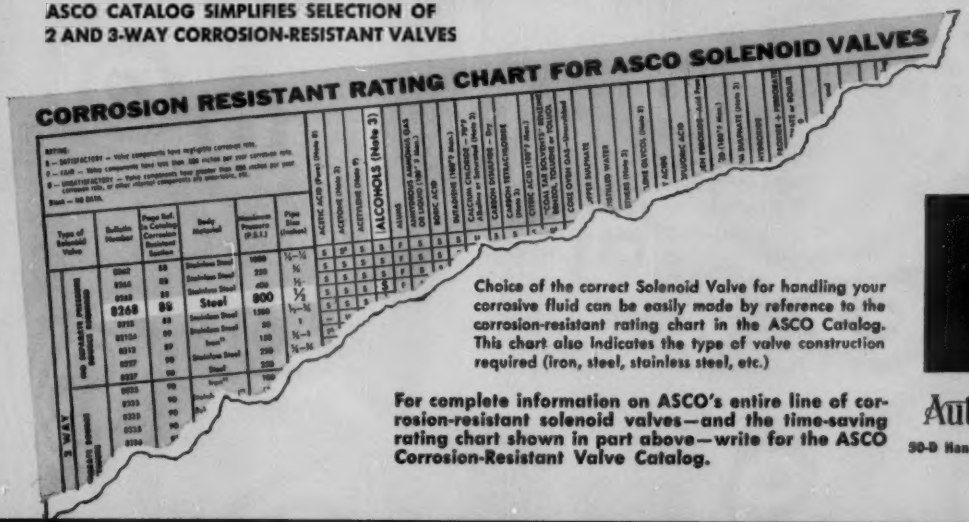
ASCO is the single source for a complete selection of Solenoid Valves capable of controlling corrosive gases and liquids.

Fully automatic or manual reset 2 and 3-way valves are available; 2-way valves can be obtained which are suitable for operating with or without a separate pressure source. Pipe sizes range from 1/8" to 6"; pressures to 1500 PSI, temperatures to 600°F. Catalog listed body materials include, for example, cast iron (with nickel alloy trim), cast steel (with stainless steel trim), stainless steel and monel – with rubber or glass linings. Many other types of body and trim material are available – or special valves can be designed to your specific application. All valves are available with standard, watertight or explosion proof solenoid enclosures, to meet any installation requirement.

Fluids handled range from sulfuric acid to sodium hydroxide – and include a variety of materials such as vegetable oils, distilled water, acetylene, coke oven gas, etc.

ASCO CATALOG SIMPLIFIES SELECTION OF 2 AND 3-WAY CORROSION-RESISTANT VALVES

CORROSION RESISTANT RATING CHART FOR ASCO SOLENOID VALVES



Choice of the correct Solenoid Valve for handling your corrosive fluid can be easily made by reference to the corrosion-resistant rating chart in the ASCO Catalog. This chart also indicates the type of valve construction required (iron, steel, stainless steel, etc.)

For complete information on ASCO's entire line of corrosion-resistant solenoid valves—and the time-saving rating chart shown in part above—write for the ASCO Corrosion-Resistant Valve Catalog.

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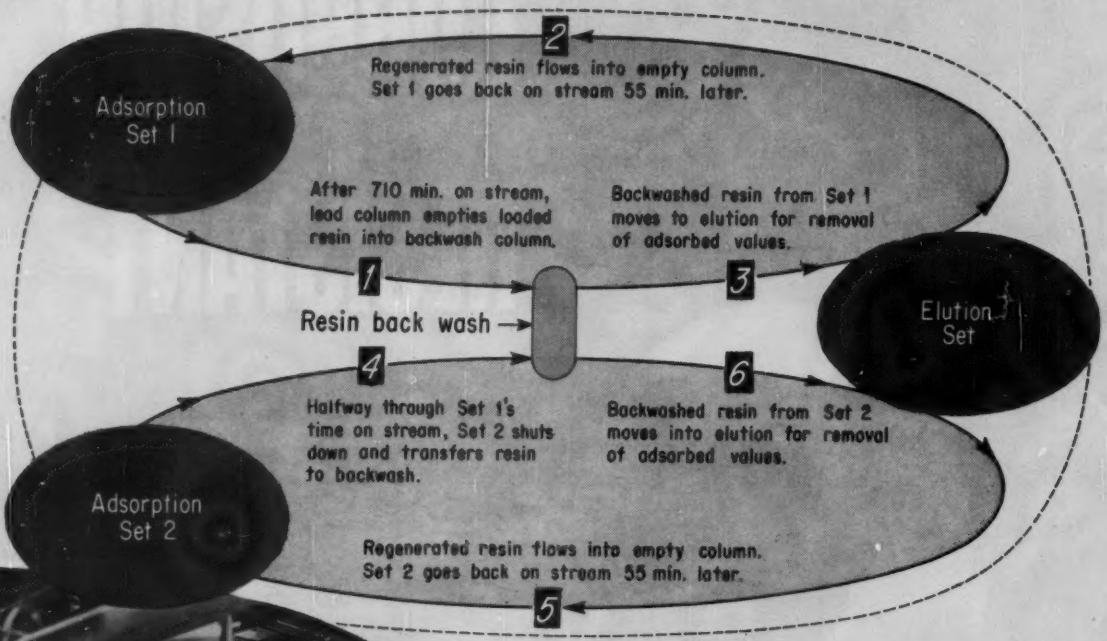
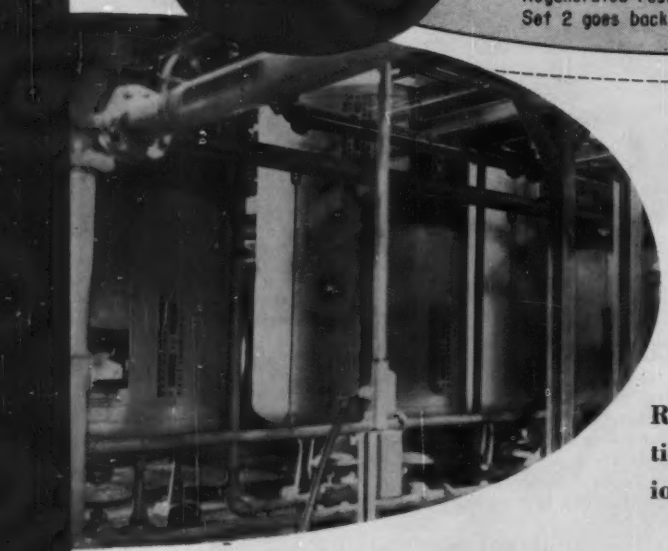
Six Steps Maximize Time on Stream


Adsorption Set 1
2
Regenerated resin flows into empty column. Set 1 goes back on stream 55 min. later.
After 710 min. on stream, lead column empties loaded resin into backwash column.
1
Backwashed resin from Set 1 moves to elution for removal of adsorbed values.
3
Elution Set
Resin back wash
4
Halfway through Set 1's time on stream, Set 2 shuts down and transfers resin to backwash.
6
Backwashed resin from Set 2 moves into elution for removal of adsorbed values.
Adsorption Set 2
Regenerated resin flows into empty column. Set 2 goes back on stream 55 min. later.
5



Resin beds that move between separate adsorption, backwashing and elution circuits upgrade ion exchange in uranium mill.

Moving Beds Double Ion Exchange Capacity

In its first U. S. installation, R. R. Porter's moving-bed ion-exchange system is widening the performance lead that it posted in 1957 and early '58 when it set new standards in six Elliot Lake, Ont. uranium mills.*

At Lucky Mc Uranium Corp.'s new 25,000 ton/mo. mill at Riverton, Wyo., (*Chem. Eng.*, May 5, 1958, p. 45) Porter's moving-bed system recovers 2.0 lb. of U_3O_8/day/cu. ft. of resin utilized—0.5 lb. higher than Consolidated Denison's pioneer system at Elliot Lake and some 0.9-1.0 lb. higher than fixed-bed systems.

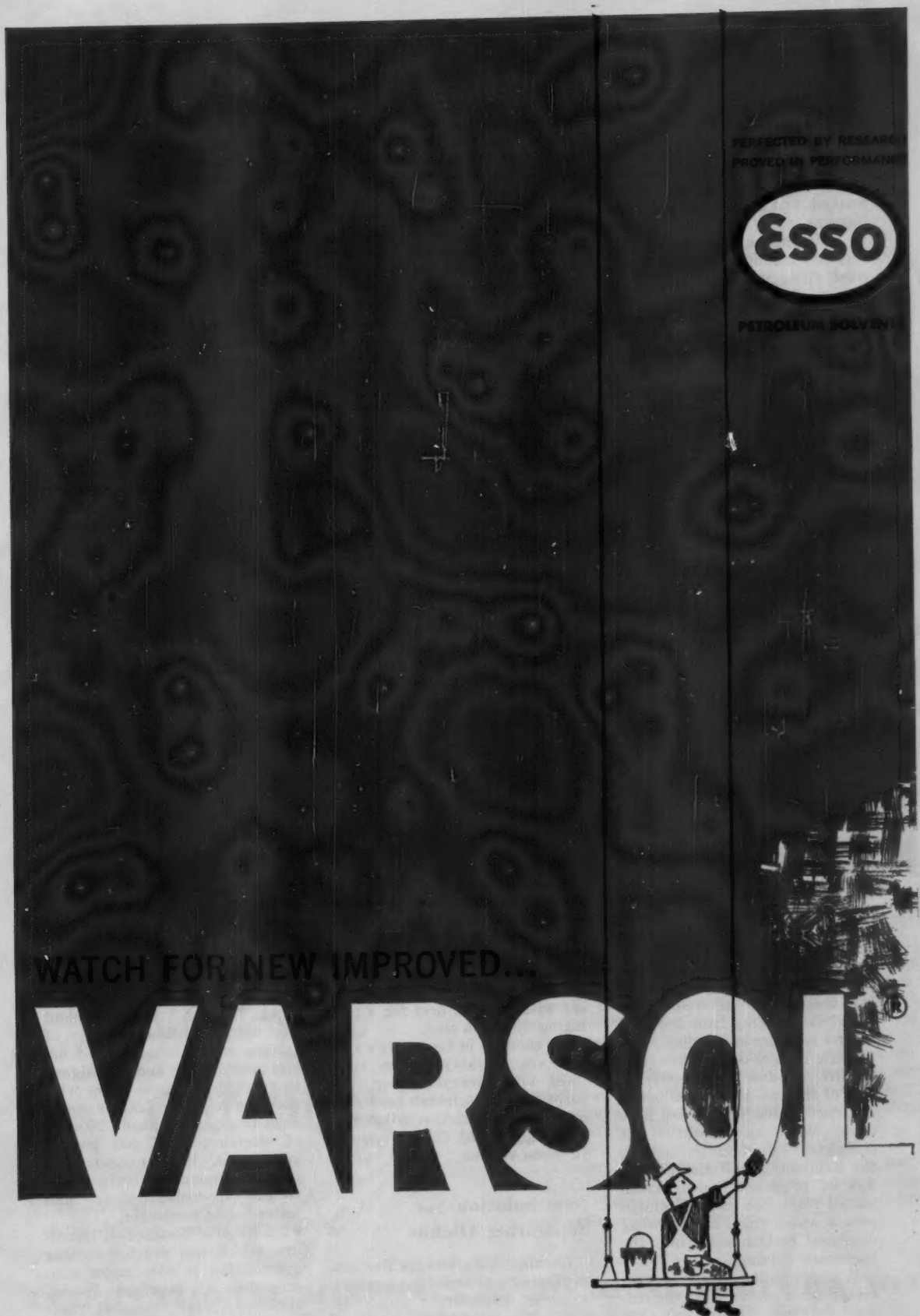
▶ **Know-How Ripens**—While granting that Lucky Mc works with higher grade ore than the Elliot Lake mills, Salt Lake City consultant Porter feels that Lucky Mc's operation owes much of its improved performance to "increased knowhow."

What Porter means is exemplified, in part, by Lucky Mc's ability to operate with the adsorbent resin beds actually on stream 93% of the time. And during that time on stream, high flow rates through the resin beds maximize rate of exchange.

▶ **Lucky Mc Reaps**—Among the benefits resulting from the system's characteristics are:

• Lower capital cost—down 15% from level of comparable fixed-bed system. (*Continued*)

* Consolidated Denison Mines Ltd., Can-Met Mines Ltd., Panel Mines, Spanish American Mines, Mulligan Mines, Lake Nordic Mines.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VARSOL®

• High recovery of uranium values—94-96% from ore containing 0.25% U_3O_8.

• No accidental mixing of pregnant and eluting liquors because resin is loaded, backwashed and eluted in separate columns.

• Higher utilization of adsorption columns because backwash space is eliminated.

▶ **Why Resin Moves**—Porter's system moves the resin beds in order to reach essentially continuous operation of the adsorption circuit. As soon as resin becomes loaded, hydraulic pressure displaces it out of the adsorption bank into a backwash column and eventually into an elution column. Fresh regenerated resin from an elution column immediately moves into the emptied adsorption column and it then goes back on stream (note illustration).

Lucky Mc's system, engineered by Dorr-Oliver in conjunction with Porter, uses 10 columns: Six 7-ft. dia. adsorption columns which operate as two parallel circuits arranged for series flow, one backwash column and three elution columns. High degree of automation enables one operator to run the entire operation.

▶ **Leach Liquor Feed**—Feed for the ion-exchange columns is pregnant thickener overflow from countercurrent decantation of sulfuric acid leach liquor and ore residue. Pumped to the tops of the two adsorption banks, pregnant liquor enters each set at 223 gpm. rate. Barren liquor discharges from last columns either directly to waste or back to the thickener circuit.

Automatic colorimetric assaying checks constantly on entering feed liquor as well as on liquor discharging from first and second adsorption columns. Volumetric meters control flow.

▶ **Shift Loaded Resin**—Operation of the two adsorption banks is programmed on an alternate basis. When an adsorption set completes 710 min. on stream, the automatic cycle timer stops flow of pregnant liquor. Then, loaded resin bed in first column gets a water rinse before being displaced hydraulically into the backwash column.

Without delay, fresh regenerated resin moves from the elution section into the empty adsorption column and the bank swings back on stream. Automatic flow sequencing now places the freshly filled column in the last position on the three-column string. Total elapsed time for switchover is only 55 min.

▶ **Elute in Separate Circuit**—In the meantime, loaded resin in the backwash column is flushed for one hour to remove slimes. Then, it moves hydraulically to an empty column. Here, elutriant containing 20-22 gpl. sodium nitrate strips uranium off the loaded resin during 90-min. cycle.

As a final step, Lucky Mc recovers the nitrate ions from the resin by washing the beads with 10% sulfuric acid. In this fashion, nitrate ions are retained within the elution circuit while the less expensive sulfate ions are exchanged for uranium ions during the adsorption cycle and discharged from the system in the barren leach liquor.

▶ **Fringe Benefits**—Bolstering the primary advantages of the moving-bed system are several lesser but very important benefits.

Because relatively coarse resin beads (0.52 mm. dia.) are specified for this system, it can operate with a pressure drop of only 20-50 psi. across the adsorption section at 200-500 gpm. flow rate. Pressure drop through the elution stage is 12-15 psi. at 100 gpm. flow rate.

Coarseness of the resin plus the scrubbing action produced during transport of the beds prevents slime buildup and plugging, keeps beads from depolarizing. Thus, thickener overflow can be run through the adsorbers without need first for a polishing filtration step.

All columns in Lucky Mc's system are ordinary carbon steel lined with natural rubber (adsorption and backwash columns) or neoprene (elution columns). Bed depth is 6½ ft. for 250 cu. ft. resin volume.

New Solution for Separating Olefins

Germany's Farbwerke Hoechst is piloting a process that employs a silver fluoroborate scrubbing solution to separate olefins from a mixture of cracked gases. Firm claims that $AgBF_4$ solutions dissolve more olefin per unit volume than any other salt solution tested and that method can be used to produce polymerization-grade ethylene and propylene.

Countercurrent scrubbing of cracked gases with solution containing 800 gm./l silver absorbs olefins as a complex leaving CO, CO_2, N_2 and H_2 behind. Heating the salt solution drives off olefins and absorbent is recycled.

Hoechst's pilot plant separates about 100 cu. ft./hr. of olefin per cu. ft. absorption volume. Losses of silver solution are negligible. One hazard: If acetylene is present in gas mixture, silver acetylide may build up in system with accompanying explosion danger. In these cases, acetylene must be eliminated before scrubbing with $AgBF_4$.

Atomic Energy Progress: Research, Building Boom

Summer months spawned renewed atomic activity in the U. S., Scotland and U. S. S. R. for both research and power-reactor building programs.

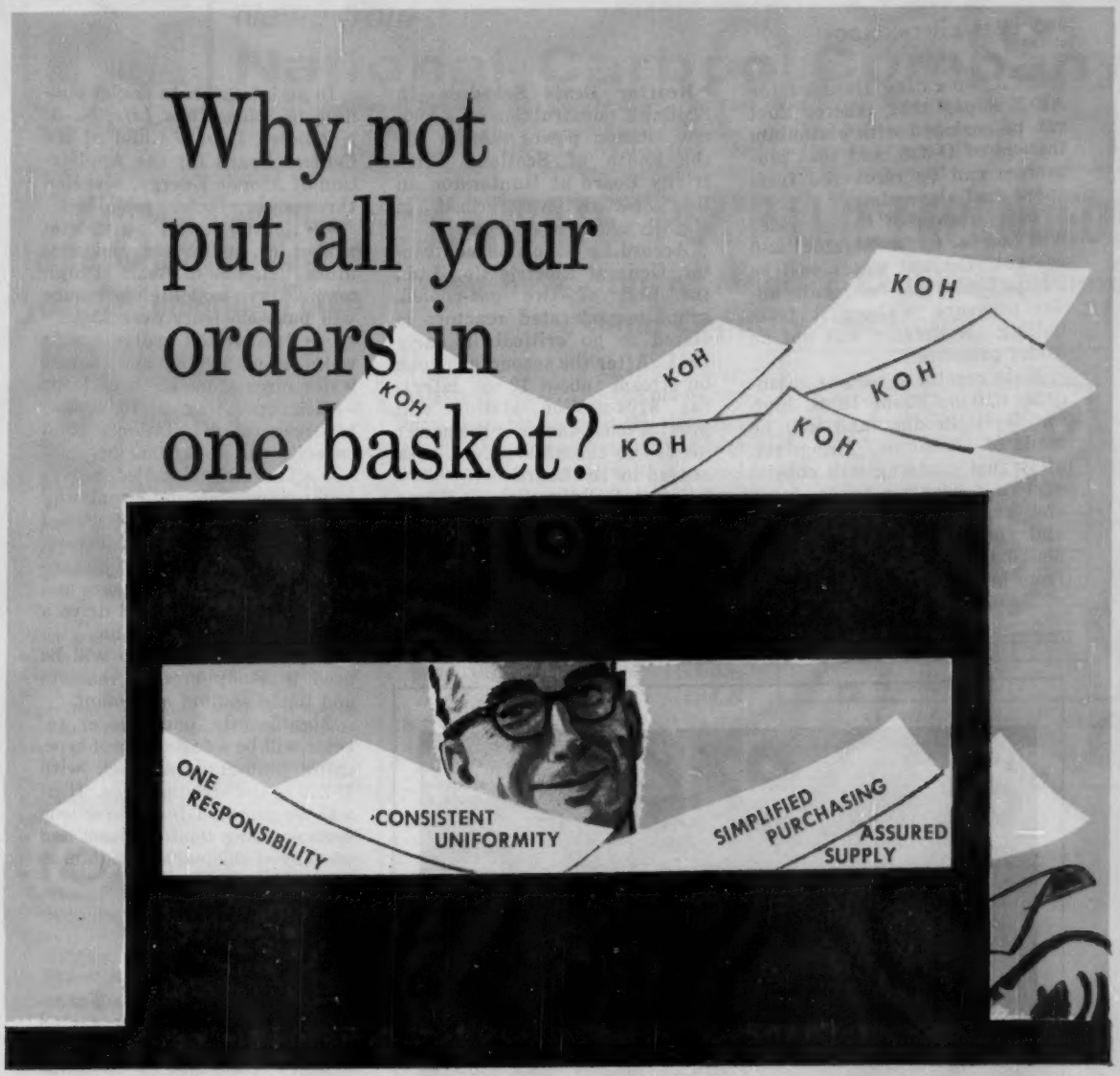
Two significant developments marked U. S. progress.

Last month, Argonne Low-Power Reactor (ALPR) went critical at Atomic Energy Commission's National Reactor Testing Station at Idaho Falls, Idaho. A natural-circulation, boiling-water reactor fueled with enriched uranium, ALPR uses light water as moderator and coolant, heats turbine steam directly in the reactor core (direct-cycle operation).

ALPR is a "package" plant that can be built on any type of terrain with a minimum of on-site construction and is designed to operate for three years with each fuel loading. Reactor can be used to generate about 260 kw. of electricity and 400 kw. of space heat. Reactor needs only a small amount of water since it has air-cooled rather than water-cooled condenser.

▶ **Pu-Recycle Reactor**—Plutonium-recycle test reactor costing $15 million is now under construction at Hanford Works, Hanford, Wash. General Elec-

Why not put all your orders in one basket?



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tric Co., operating Hanford for AEC, hopes that reactor fuel can be enriched with plutonium instead of U-235, and that plutonium can be recovered from spent fuel elements.

Two batches of heavy water will serve as moderator and coolant. Coolant water will be pumped past fuel elements under pressure to keep it from boiling. Moderator will not be under pressure.

Main reactor vessel, or calandria, will be about 10 ft. high and 7 ft. in dia., and will be made of aluminum. Zirconium-alloy fuel cladding will consist of two concentric tubes, inner one containing cooling water and fuel, outer one acting as heat barrier to keep moderator from heating up too much.

▶**Reactor Beats Schedule**—In Scotland, construction on a 360-mw. atomic power station for the South of Scotland Electricity Board at Hunterston on the Scottish west coast is slightly ahead of schedule.

According to prime contractor, General Electric Co., Ltd., the first of two gas-cooled, graphite-moderated reactors is slated to go critical in early 1961. After the second has gone on stream (about 12 mo. later), the $104-million station will provide one-quarter of the power needed in the 8,300-sq.-mi. area served by the board.

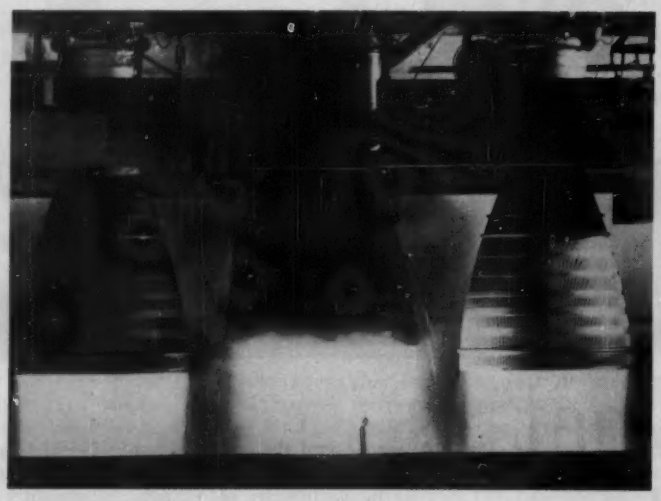
▶**Soviet Building Spree**—Three major atomic power stations and five smaller experimental installations are being built under current Soviet plans.

In an interview in Soviet publication *Science and Life*, N. A. Nikolayev, Deputy Chief of the Central Board for the Application of Atomic Energy, revealed three power reactors would be:

- Boiling-water, graphite-moderated, using enriched uranium fuel. Use of steam at high temperature and high pressure will push efficiency over 35%.
- Pressurized-water, with water as moderator, and coolant water circulating in three loops —each operating a 70,000-kw. turbogenerator. Station's total capacity will be 420,000 kw.
- Thermal gas-cooled, heavy-water-moderated and circulating carbon dioxide in primary closed loop under 70-atm. pressure. Superheated steam from secondary loop, at 30 atm. pressure and 300 C. temperature, will drive a 50,000-100,000-kw. turbine.

Experimental stations will be used to study breeder reactors and liquid sodium as coolant.

Significantly, one breeder reactor will be a fast-neutron type, using plutonium as fuel, with U-239 in the breeding zone. Heat will be removed in a three-loop system, using liquid sodium and an alloy of calcium and sodium in first and second loop.



ICBM Rocket Engines Undergo Test Firing

Mutely incongruous beside the blast of full-power test firing of Air Force-Convair 15,000-mph. Atlas ICBM, "No Smoking" sign seems definitely out of place. Liquid-propellant rocket system, designed and developed by Rocketdyne, division of North American Aviation, develops thrust from 5,000-F. combustion of liquid oxygen and RP-1, similar to turbojet fuel. Twin-chambered booster engine (left and right) provide high thrust to lift missile from the launching pad. Single-chambered sustainer (center), designed for high-altitude performance, gives slightly lower thrust to sustain powered flight. Distortion of the center chamber is caused by gimbaling to aid directional stability.

NEWS BRIEFS

Pipeline: Texas Eastern Transmission Corp. has now started oil products flowing to a delivery terminal in Lebanon, Ohio, through 1,800 mi. of its Little Big Inch Pipeline.

Nitrogen tetroxide: Hercules Powder Co. at its Hercules, Calif., plant, is constructing a pilot plant for manufacture of nitrogen tetroxide, an oxidizing material of interest to rocket fuel technicians.

Refinery: Societe De La Raffinerie, a new company formed by seven oil firms, will operate a 2-million-ton/yr. refinery near Algiers. Founding companies are: Jersey Standard, Beryl Algerie, Compagnie Francaise Des Petroles, Compagnie Francaise De Raffinage, Mobil Oil Francaise, Societe Francaise Des Petroles B. P. and Societe Shell D'Algerie.

News from
National Carbon Company
Division of Union Carbide Corporation · 30 East 42nd Street, New York 17, N. Y.
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National Carbon representatives expand your Engineering Force

S. J. MILLER—SALES ENGINEER

After graduation from Massachusetts Institute of Technology with a BS degree in Chemical Engineering, Miller spent five years in process design and production supervision, including equipment specifications, economic evaluations of processes, and plant start-ups.

Miller has been a Sales Engineer with National Carbon Company since 1953. Knowing chemical plant corrosion problems from actual experience, Steve Miller is well equipped to assist engineers and plant operators on the application, design and installation of carbon, graphite and "Karbate" impervious graphite process equipment.

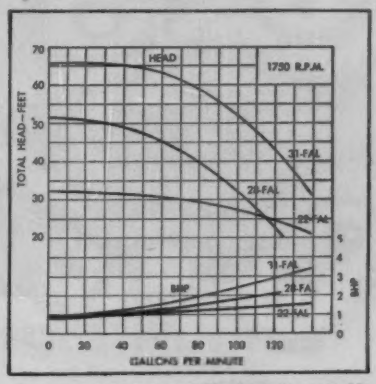
New Activated Carbon finds extensive use!

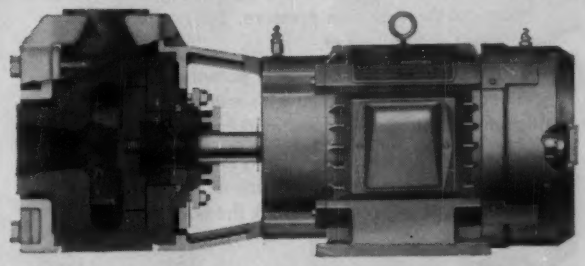
A new grade of "Columbia" activated carbon for use as a catalyst support material has been developed by National Carbon Company. Combining high activity, strength and porosity, the new grade CXC 4/6 is priced at half that of the well-known grade CXAL 4/6 it replaces. Grade CXC 4/6 is expected to give better performance than previous grades in a wide variety of additional uses. It is available in the form of 3/16" diameter pellets. For details, write National Carbon Company.

"KARBATE" PUMP LINE EXPANDED!

Three new sizes of Model F Centrifugal Pump extend Capacity and Head

Three new sizes of Model F "Karbate" impervious graphite pumps are now available to meet the demands of the chemical and metal finishing industries for greater capacities and heads. These are designated as Sizes 22-FAL, 28-FAL, and 31-FAL. Operating at 1750 RPM, capacities up to 150 GPM and heads up to 67' can be obtained. To handle fluids with specific gravities greater than water at the higher capacities and heads, the 28-FAL and 31-FAL pumps are available with 3 and 5 horsepower motors. The chart on the right shows performance curves for the new Model F "Karbate" centrifugal pumps.



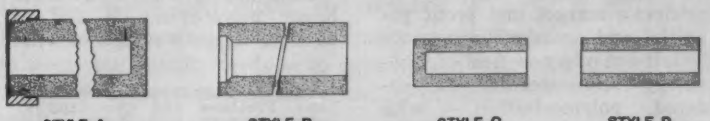


Model F "KARBATE" Pump withstands rough handling

A Model F "Karbate" impervious graphite pump has operated successfully for three years in a large refinery's portable equipment cleaning unit. The "Karbate" impervious graphite parts of the pump withstood the abuse normally encountered in this type of service. However, when changing the seal, the steel support casting was damaged. The body bolts were tightened so hard that the pressure broke the casting. The "Karbate" volute case and cover were not even chipped. Here is proof that "Karbate" impervious graphite pumps are built to "take it" and that the armored design minimizes the possibility of damage even under the most severe operating and poorest maintenance conditions.

Porous Carbon Filter Tubes available from National Carbon Company

National Carbon Company can produce and supply all styles of porous carbon filter tubes for tube type filtering equipment. Tubes having any I.D. and O.D.'s up to 6⅝" with lengths up to 36" can be manufactured from available stock. In addition, Grade 40 porous carbon filter tubes, Style B, 2⅛" I.D. x 4½" O.D. x 36" long are in stock for immediate delivery. Sizes and prices of porous carbon filter tubes will be supplied upon request.



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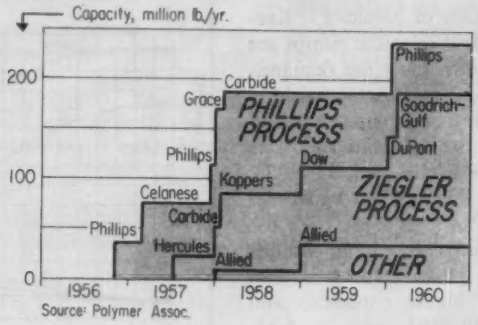
UNION CARBIDE

Q. What's Happening to Linear Polyethylene?

A. Capacity Buildup: Furious



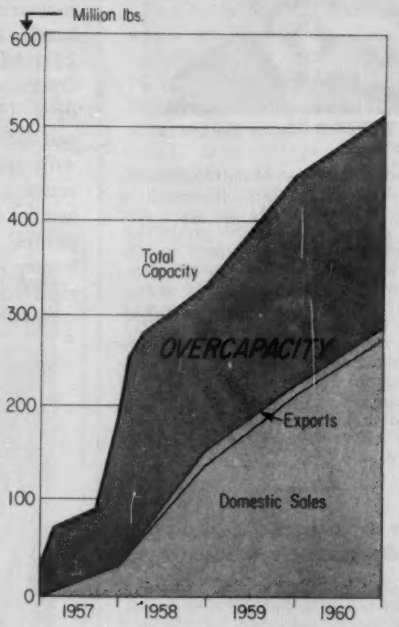
A. Controversy: Unsettled

Polymerization at low pressure figured to be more economical than at high pressure. But real cost savings haven't shown up yet.

Du Pont's composition-of-matter patent covers a specific linear poly no matter how it's made. But what about material with other specifications?

A market killing for linear poly seemed inevitable a year ago. Now polypropylene and medium-density polyethylene threaten to rock the boat.

A. Market Pickup: Leisurely



"NEVER have so many built so much to serve so few." This paraphrase of Churchill's famous lines sums up, as well as any single sentence can, linear polyethylene's* boisterous crash program of the past three years.

In those three years seven major companies have brought linear-polyethylene plants on-stream. Close to a dozen more are known to be in the pilot-plant stage of evaluation or beyond.

U. S. capacity—already nearing 300 million lb.—will soar to 445 million lb. in 1959, to 510 million lb. by 1960's end.

What are the sales prospects to warrant such enthusiasm? The most optimistic projections peg consumption at no better than 135 million lb. this year, 270 million lb. in 1960, 400 million lb. in 1962. Thus, linear-polyethylene overcapacity will run from 200-300 million lb./yr. through 1960; the gap won't really begin to close before 1962.

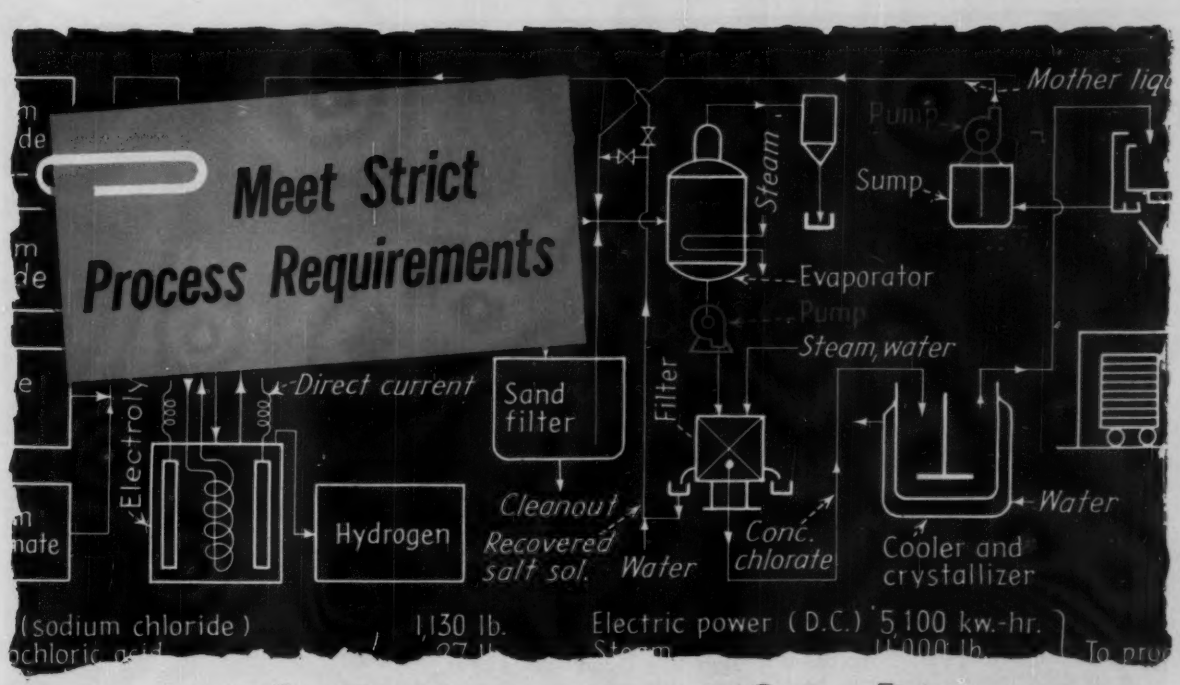
▶ **Built on Faith**—That all the companies entering the race fully expected a heavy overcapacity for several years attests to a remarkable faith in the product's market and profit potential and an unwillingness to be left out of a new field of technology—stereospecific, or ordered, polymerization — with fabulous long-range possibilities.

Any report that traces evolution of this product and its technology, assesses its present status, conjectures on its future —and does it thoroughly—makes good reading. A recent 168-page study by a group of Harvard Business School graduates is that kind of report.* It pulls together—and straightens out—many tangled trends in linear polyolefin development: patents, licenses, process economics, plant startups, end-use breakdowns.

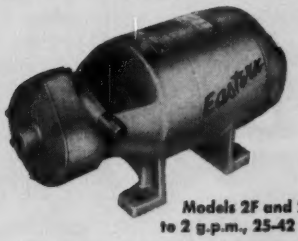
Like any youthful industry, linear polyethylene is full of puzzles. Here's a sample of what

*Variously referred to also as "low-pressure", "high-density", "ordered", "crystalline", or "isotactic" polyethylene.

*"Linear Polyethylene and Propylene: Problems and Opportunities," Polymer Assoc., 6613 Wenonga Rd., Kansas City, Mo.



. . . with Eastern Centrifugal Pumps



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to 7.5 g.p.m., to 18 p.s.i.

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Models U-17 and U-34
to 38 g.p.m., to 21 p.s.i.

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Recent redesign of these close-coupled Centrifugal Pumps has gained tremendous ruggedness and allowed for a wide selection of power requirements. In every detail of size, weight, space requirements, power, and costs, Eastern pumps fill the bill for strict process standards.

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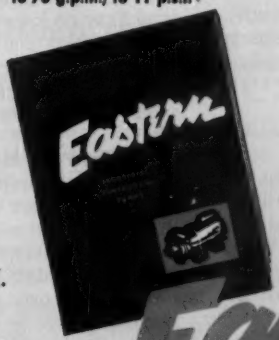
Eastern's engineering service offers many special models to meet your specific needs as to capacity and construction. Recommendations entail no obligation, and your inquiries are invited.



NEW EASTERN CATALOG

Eastern Centrifugal Pump Catalog contains engineering data, performance charts, diagrams and helpful general information. Request Bulletin 110F.

Eastern

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Linear-Poly Uses: Molded Products Place First

(Million Pounds)

Market	1958 Linear Poly	1958 All Poly	1960 Linear Poly	1960 All Poly	1962 Linear Poly	1962 All Poly
Molded products	50	165	90	220	115	270
Film & sheet	20	230	40	340	90	465
Monofilaments	25	27	35	38	50	53
Pipe	5	75	17	102	25	135
Wire & cable	10	95	25	130	30	150
Coatings	5	55	30	100	45	135
Containers	5	28	20	45	30	60
Export	15	125	12	92	15	85
Total	135	800	270	1,070	400	1,350

Source: Polymer Assoc.

the polyolefin report says about some of them.

▶ **How Good Is Linear Poly?**—Special properties — increased rigidity, tensile strength, heat and chemical resistance, impact strength—mark linear poly as an outstanding new polymer, make no mistake.

But conventional, or low-density, polyethylene—hugely successful in so many applications—will not yield much of its present markets. The report predicts no more than a 15-25% overlap in usage for the old and new polymers. At least half of linear-poly's markets will be in areas served now by other plastics.

And so-called medium-density resins are already growing at linear-poly's expense. They have some advantages over both low- and high-density polyethylene in certain uses. Some of their properties approach those of linear poly.

"Medium - density polyethylenes may well satisfy property requirements of many applications at a lower price than high-density resins."

▶ **How About Polypropylene?**—The newest ordered polyolefin, polypropylene, is figured by the report's authors to hold the same edge, in terms of properties, on linear polyethylene as the latter holds on conventional polyethylene. They look on it as an intermediate material between polyethylene and high-performance plastics like nylon.

Production of polypropylene may well be more economical than linear polyethylene production, too. Solvents aren't necessarily required, good yields are possible without extraction. Cost of the raw material, propylene, runs 1-2¢/lb. under cost of ethylene, although increased demand for propylene will close this spread.

Propylene's ability to be liquefied at relatively low pressures (compared to, say, ethylene) should afford economies in its transportation and purification.

▶ **Leapfrog**—So great is polypropylene's potential that "industry may find it advantageous to shift capital resources from planned high-density polyethylene expansion into polypropylene capacity if possible." Some manufacturers have decided to bypass high-density poly entirely, according to the report.

The report implies future fireworks when it says "it appears production costs for polypropylene are sufficiently low enough that polypropylene producers who have no low- or high-density poly capacity could economically undercut the prices of both materials to capture a substantial part of the large polyethylene market."

▶ **Can Du Pont Make It Stick?**—Du Pont's "composition-of-matter" patent most certainly shook up the linear-polyethylene picture. If upheld, it conceivably could invalidate all previous process and product patents for linear polyethylene.

But Du Pont's patent had to, of course, specify the material under consideration—its melting point, density, degree of chain branching, etc. The polyolefin report poses the question "What about a material differing in one or more characteristics specified by Du Pont in its patent?" A good question, one that will take a lot of time to answer.

Meanwhile, few companies are having any part of Du Pont's offers to license on the strength of its patent. Let the other licensors, Phillips, Ziegler, Standard of Indiana, defend their patents against Du Pont's claims—this seems to be the industry position right now.

Everything taken into account, though, the report's authors doubt that the patent problem "will ever assume large enough proportions to jeopardize the future of linear polyethylene."

▶ **Low Pressure Cheaper?**—In addition to producing a very different polyethylene, low-pressure polymerization was supposed to possess certain inherent economic advantages over the old methods at higher pressures.

Thinner-walled processing equipment, reduced compression requirements, less overall hazard to personnel, nearly complete conversion in a single pass, ability to use an impure ethylene feed—all these advantages were predicted.

All this has pretty much come true. But the benefits realized have been offset by some new drawbacks.

▶ **Other Side of Story**—Lower pressures necessitate larger reactor volumes, greater cooling area. Some processors insist successful low-pressure polymerization depends upon high-level purity of raw materials and catalysts.

These new catalysts are especially toxic, inflammable, expensive to prepare, tend to become poisoned, and are tough to get out of the final product. Solvents —and attendant recovery facilities—are a necessary part of low-pressure ethylene polymerization.

Investment costs seem to be running at about two pounds of capacity per investment dollar—about the same as at high pressures. Total costs for low-pressure polymerization may run 1-3¢/lb. higher.

Report conclusion on this subject: "Low-pressure systems, in general, have not offered any ap-

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Quick Facts

- Fibrous filter. Interlocked microfine synthetic fibers on which ultrafine asbestos fibers are dispersed.
- New "Air Flotation" process forms the medium.
- Concentration gradient of ultrafine asbestos fibers insure higher filtering efficiency, lower breathing resistance and longer service life.
- All fibers bonded together by special fusion process.
- Precision AO built-in red prefilter for positive identification and thermally bonded to main filter for extra long service life.
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Highlights from the Polyolefin Timetable

1943: I. G. Farben uses organometallic catalysts to produce high-density polyethylene for German war effort.

1947: General Aniline & Film chemists come up with first known case of stereospecific, or ordered, polymerization of an olefin.

Du Pont seeks patents on "substantially linear polyethylene" made at very high pressures. Patents subsequently denied.

West Germany's Karl Ziegler finds organometallic catalysts which transform olefins into many useful products.

1953: Ziegler adds transition metal halides to aluminum alkyls to promote ethylene polymerization even at atmospheric pressures.

Ziegler receives patents on his family of catalysts.

Phillips Petroleum seeks patents on use of chromium oxide catalysts to polymerize olefins at moderate pressures and to produce a linear polyethylene.

1954: Du Pont patents processes for making poly at low pressures.

Italy's Giulio Natta uses new catalysts to control chain growth in olefin polymers—particularly polypropylene—according to predetermined specifications.

Hercules Powder discovers how to make isotactic, or ordered, polypropylene using Ziegler catalysts.

Standard of Indiana and Phillips succeed in making polypropylene using their own processes.

Standard of Indiana receives patents on use of preformed solid catalysts to produce olefin polymers, including a high-density, highly crystalline polyethylene.

1956: Imperial Chemical Industries says existing high-pressure polyethylene plants can be modified to produce medium-density polymers whose properties approach those of linear polyethylene.

Phillips brings world's first linear polyethylene plant on stream at Pasadena, Texas. Capacity: 75 million lb./yr.

1957: Montecatini, with all commercial rights to Natta's findings, expects to supply polypropylene to American market in 1958.

Celanese brings 40-million-lb./yr. linear-polyethylene plant on-stream at Pasadena, Tex., just 18 months after getting Phillips license.

Celanese and National Lead join in program to produce improved plastic and fiber polymers via new polymerization catalysts.

Koppers announces cancellation of joint project with Brea Chemicals to produce low-pressure poly at West Coast site.

Hercules, aided by development know-how from Farbwerke Hoechst, brings in first Ziegler linear-poly plant—rated at 20 million lb./yr.—at Parlin, N. J.

W. R. Grace, a Phillips licensee, goes onstream at Baton Rouge, La. with 50-million-lb./yr. linear-poly plant.

Du Pont gets "composition-of-matter" patent as federal court overrules Patent Office rejection of 1947 patent applications. Patent appears to cover linear polyethylene no matter how it's made.

Hercules opens 20-million-lb./yr. polypropylene plant—the first in the U.S.—at Parlin, N. J.

1958: Allied Chemical builds capacity of Buffalo, N. Y. linear-poly plant to 20 million lb./yr.

Koppers, a Ziegler licensee, brings in 30-million-lb./yr. linear-polyethylene plant at Port Reading, N. J.

Union Carbide brings two linear-poly plants onstream: at Seadrift, Texas, a 25-million-lb./yr. setup using Phillips know-how; at Institute, W. Va., a 30-million-lb. job using Ziegler catalysts.

Three companies onstream by March with polypropylene plants: Italy's Montecatini, with a 15-million-lb./yr. capacity (to be quadrupled by 1959); West Germany's Farbwerke Hoechst, with a 68-million-lb./yr. capacity; and Hercules in the U.S.

Six major polyethylene producers plan to expand high-pressure capacity and will devote a good part of expanded facilities to turn out medium-density polyethylenes.

Humble Oil & Refining will build in 1959 a 40-million-lb./yr. polypropylene plant at Baytown, Tex.—biggest in the U.S. to date.

preciable cost savings to-date over high-pressure systems."

One manufacturer has indicated "the low-pressure method may never become as cheap as the older, high-pressure method."

▶ **Ziegler vs. Phillips**—The report delves even further into process economics by reviewing the various pros and cons of the two major low-pressure techniques: Ziegler and Phillips.

First of all, it isn't correct to say Ziegler had a process to license at all. He furnished a recipe for a catalyst, together with basic operating conditions—his licensees had to build a process around them.

Phillips, on the other hand, offered a package: complete specifications for the product, plant design and engineering. Thus Phillips and its licensees, although starting later than Ziegler licensees, got a big jump in bringing capacity onstream.

Further complicating the picture for Ziegler processers was the solubility of the aluminum and titanium catalysts in the final polymer. Removal is mandatory and difficult. Phillips claims its chrome oxide catalyst is insoluble in the final product.

However, Phillips catalysts have tended to become plugged—"one problem that had to be solved." Periodic regeneration of catalyst, with possible losses, may have been the result.

And some authorities say only the Ziegler process will lend itself to conversion from low-pressure polyethylene to polypropylene.

Phillips investment dollars appear to go a little further: up to 2.5 lb. of poly capacity/investment dollar vs. 1.5-1.8 lb. for Ziegler plants.

▶ **A Better Product?** Phillips-licensed producers claim higher densities and crystallinity, with correspondingly higher rigidity and heat resistance, than do Ziegler producers. Ziegler specifications so far: densities of 0.940-0.945, with 75-85% crystallinity. Phillips' claims: densities of 0.958-0.962, up to 93% crystallinity.

Notwithstanding these claims, the report believes all new low-pressure processes produce nearly equivalent polyethylenes.

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New rocket fuel oxidizer.

First oxidizer designed specifically for rocketry, perchloryl fluoride is said to offer storability, stability and superior performance.

It will provide easy ignition and extremely smooth combustion. The calculated specific impulse with hydrazine is 270 sec. at a chamber pressure of 500 psia. (frozen equilibrium).

This oxidizer, ClO_3F, is liquid under moderate pressure, unlike oxygen. It freezes at −146 F., boils at −52 F. and combines the three most electronegative elements in a physically stable but chemically reactive form.

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For longer pot life, improved physical properties.

A new line of potting formulations, based on epoxy resins and using National Aniline's methyl Nadic Anhydride or hexahyrophthalic anhydride as the curing agent, is said to offer handling advantages plus a better finished product.

Pot life is longer, sometimes as much as a week. Curing is slower, therefore more readily controlled. But by adding small amounts of tertiary amines, cure time can be speeded at will. Depending on the intended application, viscosity of the formulation may be varied within wide limits.

The anhydride curing agents themselves have a lower volatility at elevated temperatures than amine curing agents frequently used. They offer superior ease of handling because one is a liquid at room temperature and the other melts at a lower temperature than do most aromatic amine curing agents.—**Mitchel-Rand Mfg. Corp., New York, N. Y. 92C**

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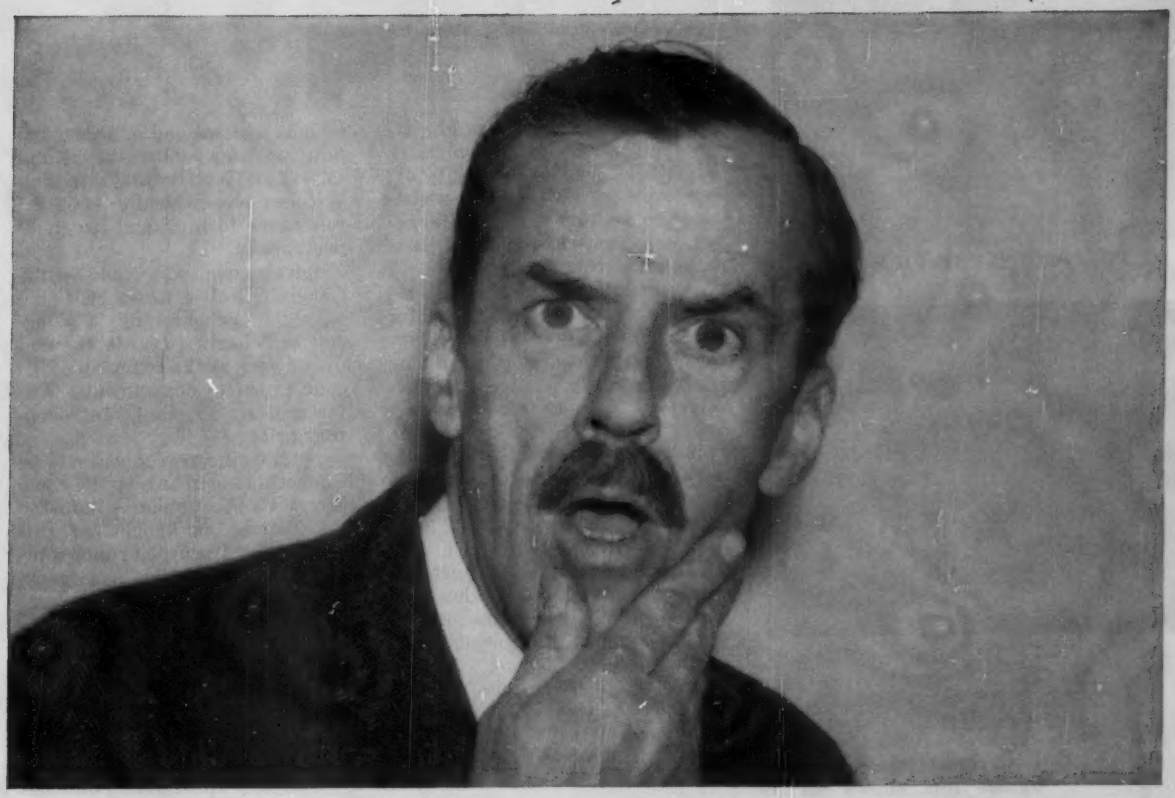
Cost is less than half the cost of asphalt shingles or composition roll roofing. And the labor cost, if professional labor is used, is less than 10% of normal.—**Montgomery Ward & Co., Chicago. 92D**



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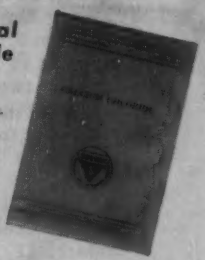

Solvay's Technical and Engineering Service Bulletin #16, "Calcium Chloride", contains 89 pages of general technical data, including physical and chemical properties, specifications, tables, charts and handling procedures. Experimental samples also available.

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POLYPROPYLENE FILM

NYLON-6

Unique Films

Both commercial firsts, propylene film shows oil resistance, nylon-6 shows strength.

New products, believed to be commercially available for the first time, include Proplene, a clear high-gloss packaging film made from Hercules' polypropylene resin; Caplene, an exceptionally strong film made from Spencer's nylon-6, expected to be competitive in the polyester film field; and two unique foamed products, Orthofoam and Metafoam, made from low and medium density polyethylene, respectively.

They are all products of new Flex-L film-making process said to impart: (1) outstanding clarity and gloss in all thermoplastic films; (2) improvement of properties through molecular orientation; (3) formation of products at optimum crystallinity.

The new plastics were first introduced to 23 large consumer goods packaging concerns, each of whom represents a different basic market. Proplene has proven suitable for processing on overwrap and bag impulse-sealing machines, and also performs well in blister and skin-type packaging. In addition to having good machineability, it is characterized by good printability and exceptional shelf life.

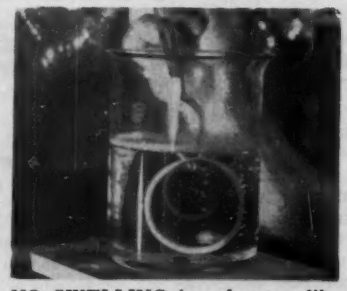
The caprolactam-based film offers advantages in the polyester film field of heat sealability, printability and excellent resistance to greases, oils, flavors, organic solvents and alkalies. It is also self-extinguishing.

Foamed polyolefin sheeting offers an entirely new medium for designers in several fields. They are thermoformable products.

Insulation values and effectiveness as moisture barriers puts them in a class with foil, plastic laminates and the higher grades of paperboard. Both are available in rolls or sheets, in 16- to 20-mil thicknesses, 60-in. maximum width.

Other new Flex-L products include high, medium and low density polyethylene films known respectively as Paraplene, Metaplene and Orthoplene. All the films, except foam films, come in thicknesses of 0.0005 in. or more, widths of 60 in. or less.—**Ludlow Papers, Inc., Needham Heights, Mass.** **94A**

Nitrile Silicone Rubber



NO SWELLING in solvent unlike enlarged silicone ring.

NO STIFFENING in dry ice unlike fluorinated hydrocarbon.

Vulnerability to oils and solvents is no longer the Achilles heel of silicone rubber. Introducing nitrile groups into the organic portion of the silicone has produced a new series of compounds which equal or better the best existing rubbers in oil and solvent resistance while retaining silicones' traditionally excellent resistance to high and low temperatures.

Development was made by the General Electric Research Laboratory in Schenectady. Production will begin towards the end of the year at the company's silicone products department's Waterford, N. Y. plant. Introductory price: $15/lb.

Nitrile silicone rubbers will be competing for many of the same aircraft and automotive industry applications as fluorinated silicone and hydrocarbon rubbers introduced within the past year. However GE believes its compounds offer an unequalled combination of advantages. Their useful temperature range is −100 to over 500 F. They are easy to fabricate on conventional equipment. They are basically lower in cost than competitors.

Company spokesmen point out that while fluorinated silicone solves much of the oil resistance problem, their relatively high cost ($25/lb.) and problems in processing limit their use.

Low temperature properties of Du Pont's fluorinated hydrocarbon are not as good as nitrile silicones'; both claim useful upper temperature limits of about 500 F. though GE believes its compounds have better potential for excelling this limit.

Raw materials for the new compounds are similar to those for other silicones; GE will not identify source of the nitrile group. Nitrile-containing silicone intermediate must be of extremely high purity. It is converted to a fluid by hydrolysis; then to a very high molecular weight polymer. Conversion to rubber is usual.—**General Electric Co., Waterford, N. Y.** **94B**

For More Information . . .

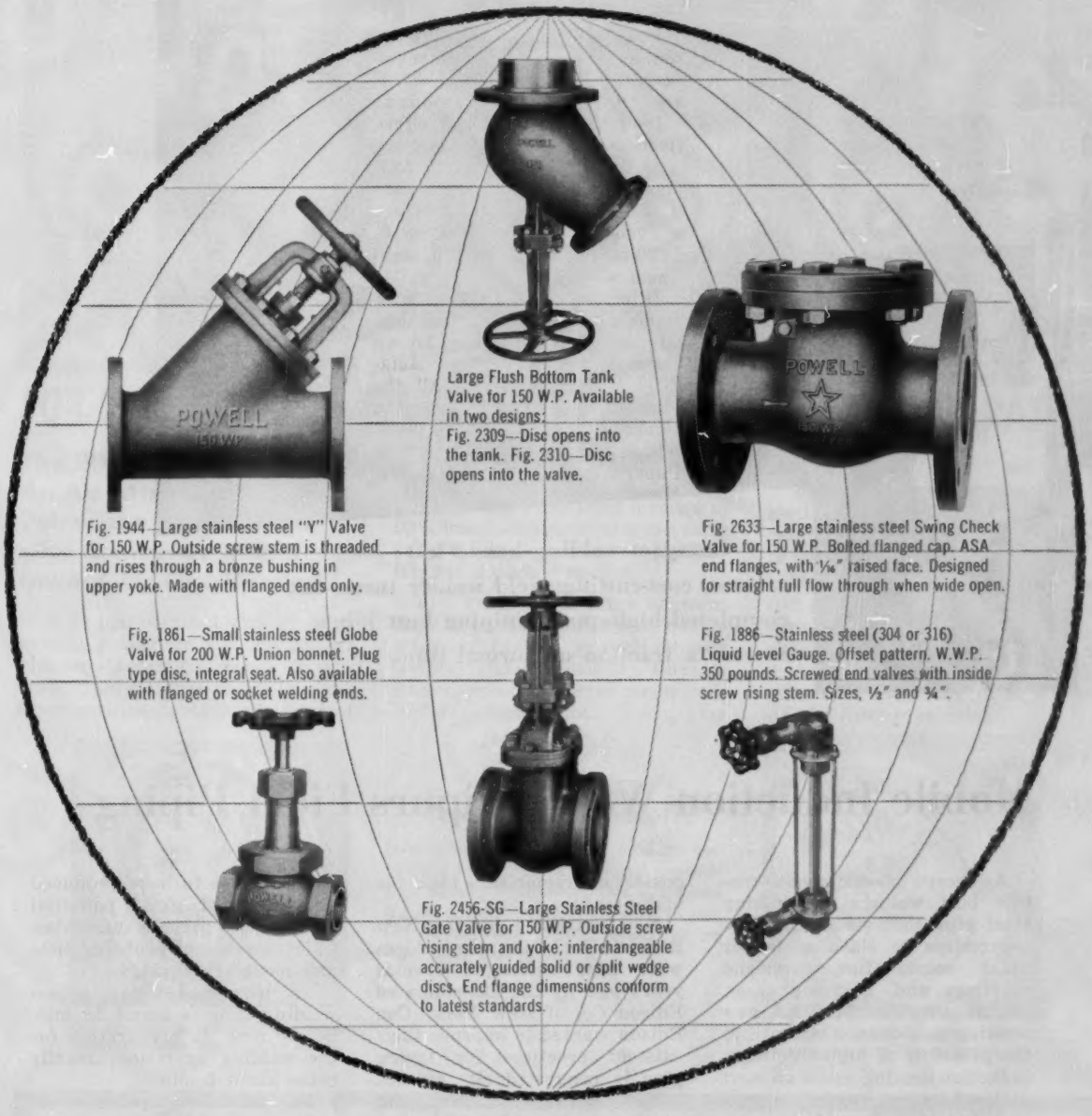
about any item in this department, circle its code number on the

Reader Service

postcard (p. 233)

POWELL

world's largest family of valves



Large Flush Bottom Tank Valve for 150 W.P. Available in two designs: Fig. 2309—Disc opens into the tank. Fig. 2310—Disc opens into the valve.

Fig. 1944—Large stainless steel "Y" Valve for 150 W.P. Outside screw stem is threaded and rises through a bronze bushing in upper yoke. Made with flanged ends only.

Fig. 2633—Large stainless steel Swing Check Valve for 150 W.P. Bolted flanged cap. ASA end flanges, with 1/16" raised face. Designed for straight full flow through when wide open.

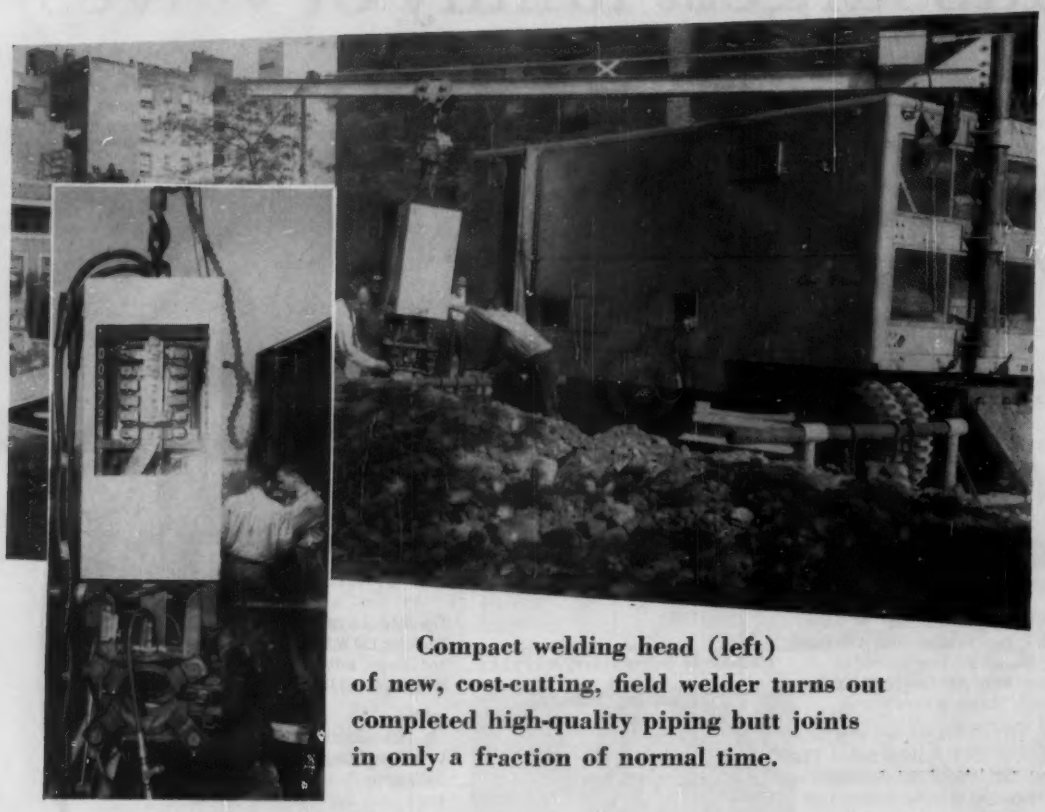
Fig. 1861—Small stainless steel Globe Valve for 200 W.P. Union bonnet. Plug type disc, integral seat. Also available with flanged or socket welding ends.

Fig. 1886—Stainless steel (304 or 316) Liquid Level Gauge. Offset pattern. W.W.P. 350 pounds. Screwed end valves with inside screw rising stem. Sizes, ½" and ¾".

Fig. 2456-SG—Large Stainless Steel Gate Valve for 150 W.P. Outside screw rising stem and yoke; interchangeable accurately guided solid or split wedge discs. End flange dimensions conform to latest standards.

A solution for every kind of flow control problem is as near as your local Powell distributor. Powell valves are designed and engineered in the largest variety of metals and alloys, to handle any medium, every flow control requirement. There are Powell distributors in all principal cities. Or, if yours is a special engineering problem, write to:

THE WM. POWELL COMPANY • *Dependable Valves Since 1846* • **Cincinnati 22, Ohio**



Compact welding head (left) of new, cost-cutting, field welder turns out completed high-quality piping butt joints in only a fraction of normal time.

Mobile Induction Welder Spurs Field Piping

A recent development—mobile butt welders for joining steel pipe sections in the field—promises to slash costs for plant construction, overland pipelines and, in some cases, maintenance work. The new welding machines, which utilize the principle of high-frequency induction heating under an inert atmosphere, can produce a completed weld in just 1½ min., excluding set-up time.

Consisting essentially of a boom-supported welding head plus trailer-mounted auxiliary equipment, the mobile welder is applicable to ground, trench or overhead pipeline installation. Resultant welds are sound, and possess characteristics ideal for high-pressure piping.

Now marketed by the New Rochelle Tool Corp., the welders were first envisaged several years ago by the Consolidated Edison Co. of New York. Con Edison wanted to improve their existent practices for laying pipe in congested city streets.

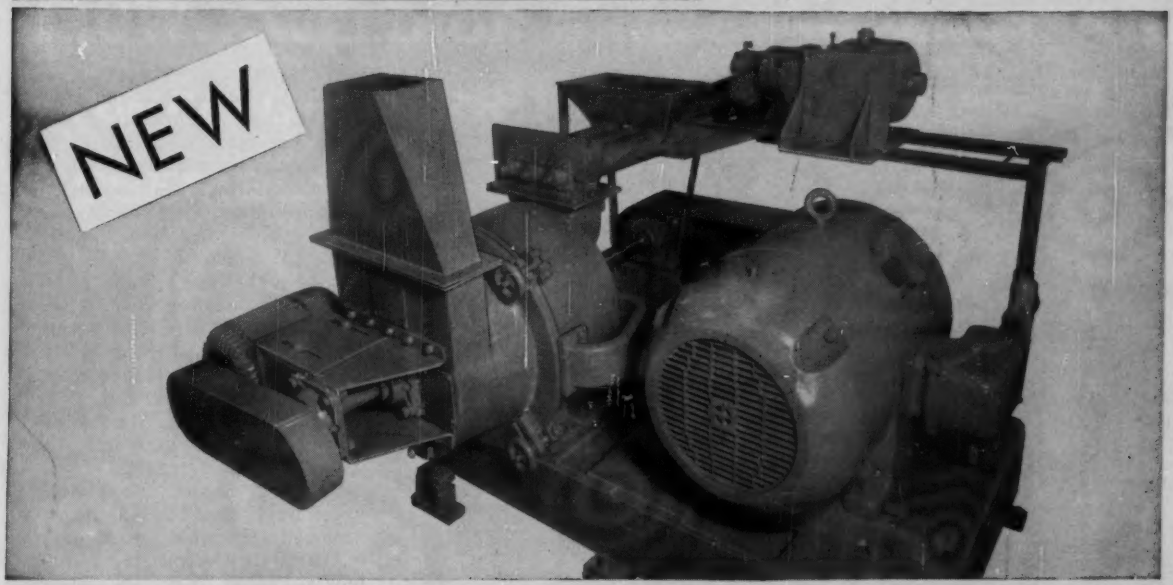
New Rochelle, a firm that specializes in high-frequency industrial machines, was given the job of building the induction heating equipment. Con Edison designed the first line-up jigs and hydraulic-pressure pipe clamps, and adapted the trailer.

▶ **Assets and Limitations**—The joint efforts of these two companies seems to have produced a product of great potential value to the process industries. Chief assets are probably time and monetary savings.

As mentioned above, actual welding time is about 1½ min. Set-up time, in preparation for the welding operation, usually takes about 5 min.

The machine's operators require no welding experience, and only a little training. These facts, when compared to current butt-welding practices, exemplify the possible savings.

Resultant weld quality is excellent. The build-up of metal, or bead, occurs around the outer periphery of the joint, while



FOR PRECISION GRINDING AND CLASSIFYING IN ONE OPERATION

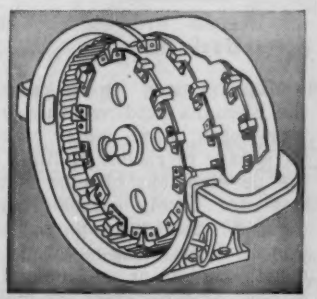
The PULVOCRON . . . An Air Attrition Impact Pulverizer and Classifier with Controlled Radial Inward Air Classification.

Now in one compact unit you can have a pulverizer and a classifier plus an automatic feeder, with separate controls over each. This assures positive particle size control and high capacity over a wide range of products. The Pulvocron will produce particle sizes from a range of 99% less than 5 microns or as coarse as 50 mesh, depending on the material and desired results.

The grinding chamber contains three adjustable plates with twelve staggered beaters on each. It also features added versatility through interchangeable liners of corrugated, perforated or smooth finish, plus variable rotor stator clearances.

The Classifier unit is on a hinged section with quick-open locks for simplicity of operating adjustment or cleaning.

Material is both ground and classified through high centrifugal pressures set up by the beater and classifier plates. The Pulvocron is designed with oversize returns for automatic feed back of any oversize for further grinding.



Grinding chamber with adjustable plates, removable liners and oversize returns.

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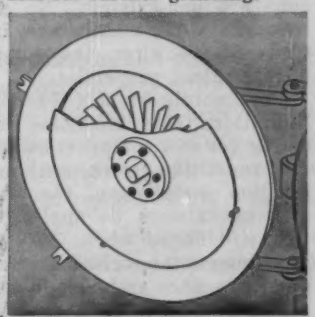

Classifier Unit with separate motor. Swings open as a hinged section with quick open locks.

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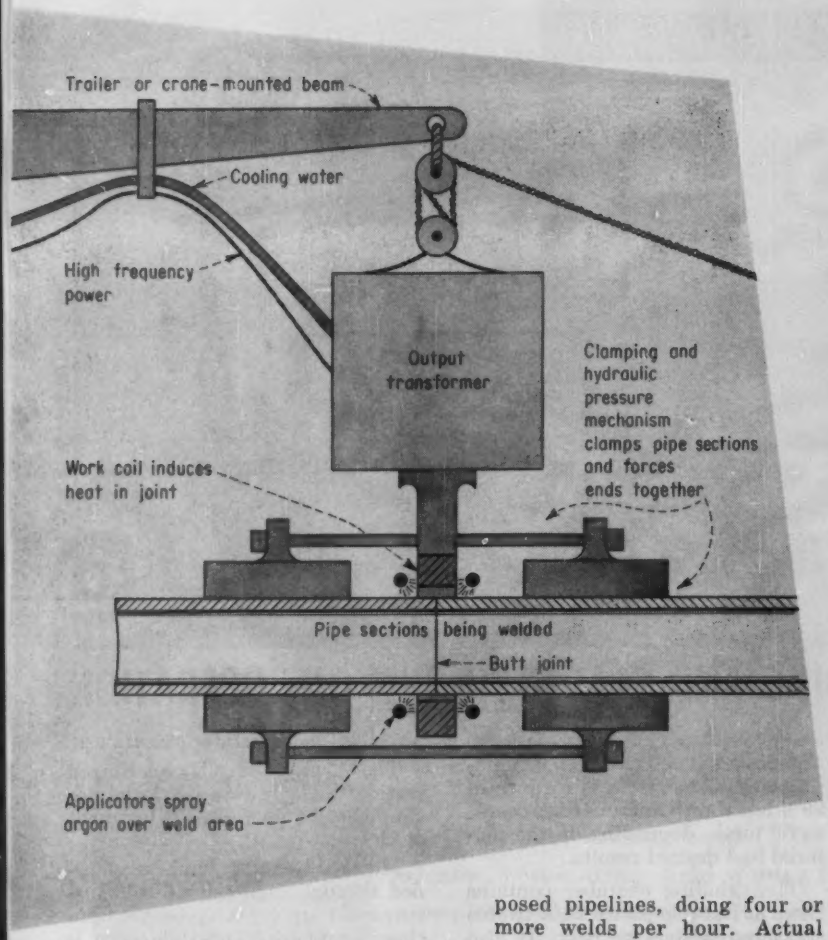
Trailer or crane-mounted beam
Cooling water
High frequency power
Output transformer
Clamping and hydraulic pressure mechanism clamps pipe sections and forces ends together
Work coil induces heat in joint
Pipe sections being welded
Butt joint
Applicators spray argon over weld area

internal pipe diameter remains full size.

Flash and slag removal problems are non-existent No extraneous weld metals are introduced to alter the pipe's metallurgical properties.

The mobile welder has its limitations, also. Designed primarily for new construction and for repetitive work such as pipeline installation, the unit may not always be applicable to maintenance work.

Although the welder is compact, clearance problems in congested plant areas may prohibit effective application. And secondly, the unit is obviously uneconomical for just one or two welds in a given area, or for very small piping where standard fittings might suffice.

▶ **Plant Use: Not Yet**—The first mobile welder, which went to Con Edison, has been in field service for several months, and has produced several hundred welds. Assembled on a 7½-ton surplus trailer, the unit moves from joint to joint along proposed pipelines, doing four or more welds per hour. Actual rate of progress depends on how well the line-up has been prepared for the clamping and welding operation.

In the past few months, New Rochelle has received numerous inquiries regarding the equipment. Most serious interest to date is coming from a number of prominent overland pipeline outfits in the U. S., South America and Europe. Fewer inquiries have come from the process industries because most firms are not yet familiar with the machine, or with its potentialities.

▶ **How It Works**—Each mobile welder has two component sections: welding head—the parts right at the pipe—and the trailer assembly.

Welding head consists of an output transformer, work coil, pipe-alignment jig and hydraulic clamps. Entire assembly can be cable-suspended from a trailer-mounted boom, or from any plant crane.

The trailer houses all auxiliary equipment. This includes a 100-kw., 10,000-cycles/sec. electric generator driven by a 150-hp. diesel engine. Also included is the unit's control panel. Both generator and diesel, as well as the output transformer, are cooled by a trailer-housed circulating-water system.

In operation, the hydraulic clamps, exerting 2,000-4,000 psi., grip the pipe sections, and force their ends together. After the work coil and split-ring, argon-gas applicator are positioned over the weld area, the high-frequency power supply is adjusted to heat the joint. Power shuts off automatically when the upset attains a predetermined shape. Work coil, argon applicator and clamps are removed—the weld is complete.

▶ **Availability**—New Rochelle is now prepared to deliver equipment for pipe up to 14 in. diameter. Larger sizes present no problems other than further experimentation with generator weights and modified trailer assemblies. Supplementary work coils for varying pipe sizes below 14 in. are also available. Each coil is good for roughly a 2-in spread about its nominal size.—**New Rochelle Tool Corp., New Rochelle, N. Y.** 96A

Flow Meter

Resists hydrochloric and sulfuric acids.

Manufactured in Germany, the Siemans acid-resisting, rotary-piston flow meter takes advantage of recent findings in the development of new materials for highly corrosive liquids. All low-stress parts contacting fluids being metered are constructed of, or are lined with a new acid-resistant phenolic resin named Bascodur; tantalum is the material of construction for parts subject to high mechanical stress.

In operation, the liquid flowing through the solid-Bascodur measuring chamber causes rotation of the carbon rotary piston. By means of a magnetic coupling, this motion activates,

These significant equipment developments are continued on page 202.

NOW...WELD OR BRAZE FOR FASTER, LOWER COST PROCESS LINE ASSEMBLY

Speedline® ALIGNING CONNECTORS ALSO INSURE POSITIVE PIPE ALIGNMENT

No pipe misalignment or "icicles" at joints with Speedline Stainless Steel Aligning Connectors. This inexpensive connector fits over stainless pipe and *Speedline Fittings*, to permit speedy welding or silver brazing of tight, leakproof, socket type joints. In-place preassembly for positive alignment *prior* to welding or brazing, reduces installation time and costs for the most complicated process piping systems.

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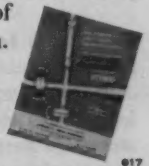
Learn how Speedline Aligning Connectors and the *complete line* of Speedline stainless steel fittings can provide process piping economy and efficiency never possible with conventional fittings. Write for a copy of "Speedline Catalog" today, at no obligation.



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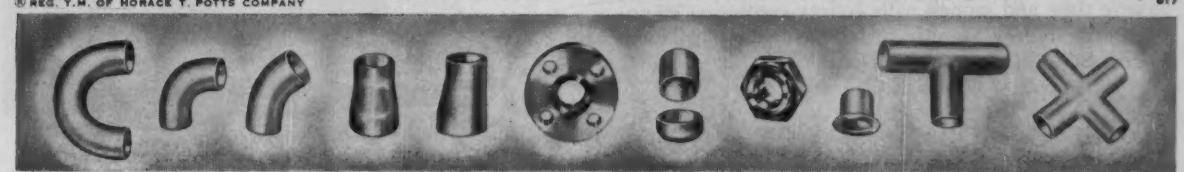

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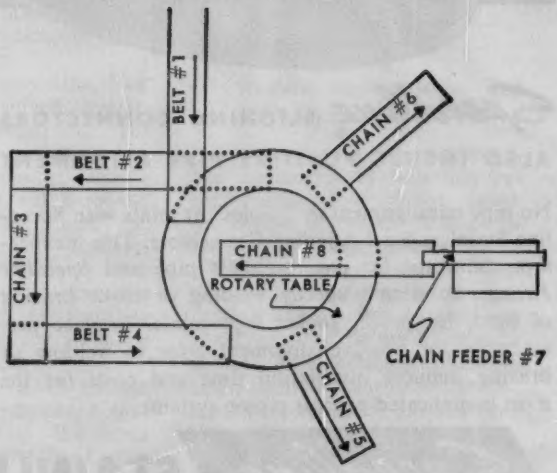
Variable barking-grinding rates synchronized by pushbutton

JEFFREY CONVEYING SYSTEM

At this pulpwood mill, barking drums prepare wood at a 0 to 30 cords per hour clip... grinders consume 4 to 12 cords per hour... Jeffrey conveyors synchronize supply and demand by merry-go-round routing and stockpiling of wood.

Here's how it works: Barked wood is discharged to conveyor #1. More than enough is diverted to conveyor #2 because correct sizes must be selected to efficiently load magazines for batch grinding. Conveyors #3 and #4 take excess wood to rotary table where remote-control plows divert it back to grinders as needed... or to stockpile conveyors #5 and #6. Any deficiency in supply from barking drums is made up by routing wood from stockpiles to rotary table via chain feeder #7 and conveyor #8.



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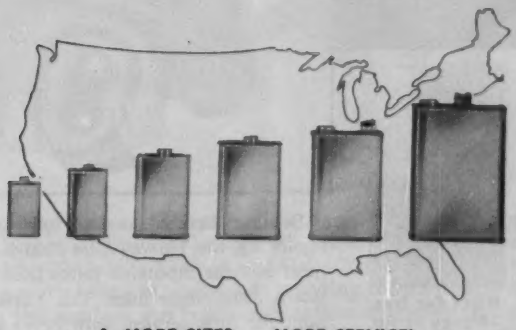

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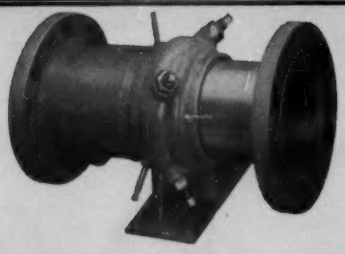

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There must be no failure at flanged connections, either. That's why Yarnall-Waring Co. uses Phoenix forged-steel flanges on Gun-Pakt expansion joints.

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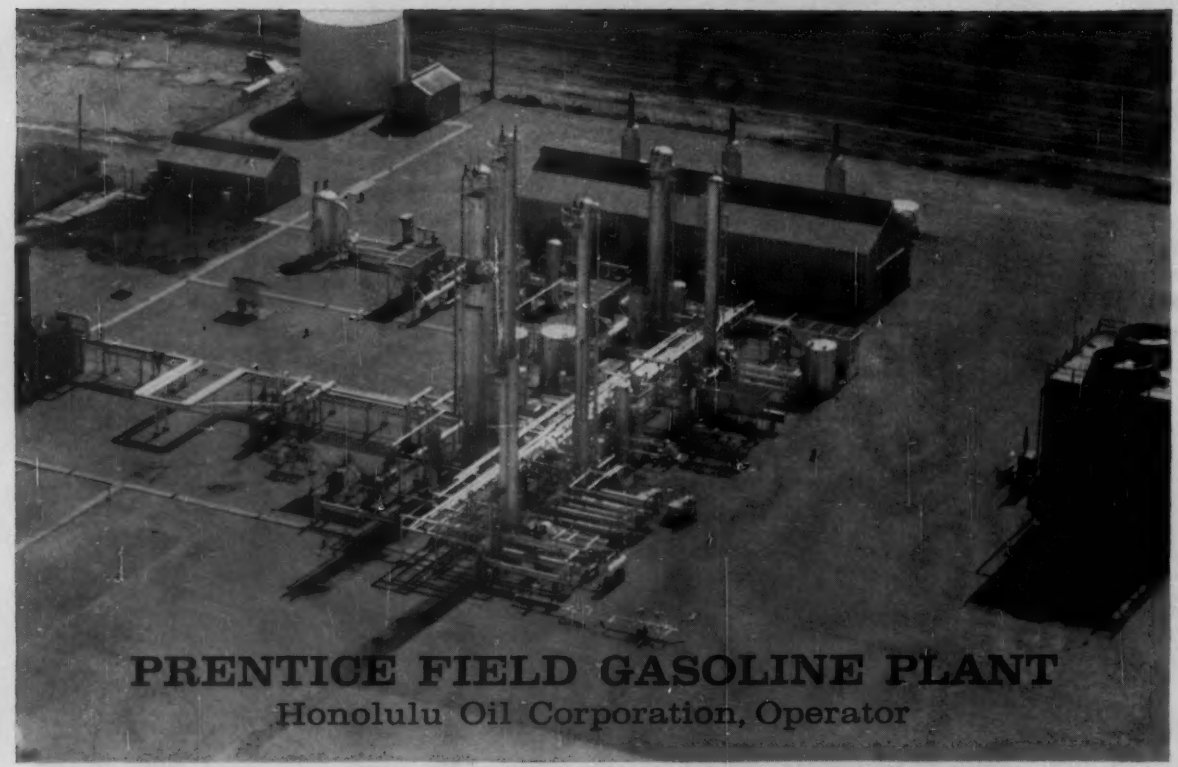

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An outstanding example of cooperative effort by the oil industry, the Prentice Field Gasoline Plant in Terry County, Texas — operated by the Honolulu Oil Corporation of San Francisco for the owners — is a model of efficient operation.

Designed to conserve natural resources and to produce oil properties from a by-product of crude oil production, the Prentice Field Plant produces 74,550 gallons per day of liquid product and a dry natural gas. These are sold by pipe line for use as fuel.

To insure efficient operation with a minimum of employee attendance, the plant is completely equipped with modern controls. For pipe lines, Jenkins Valves were specified, assuring long service life.

No other valves have such a long record of efficient, low-cost service. To building experts and plant operating men, the Jenkins Diamond on a valve has been a mark of extra value for nearly a century. Yet the valves that bear this famous symbol cost no more. Jenkins Bros., 100 Park Avenue, New York 17.

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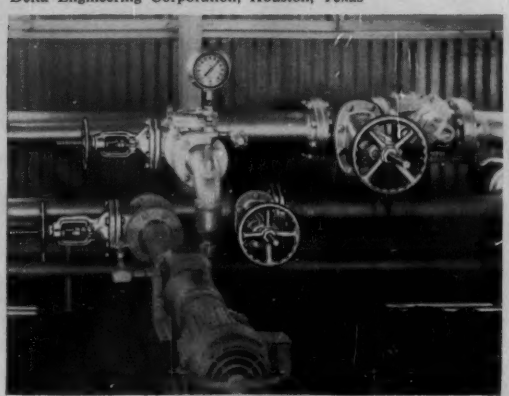

Jenkins Valves on utility water pumps at the Prentice Field Gasoline Plant. Engineers specified "Jenkins" for all standard valves in plant, which processes 12,360,000 cu. ft. per day of oil well casinghead gas.

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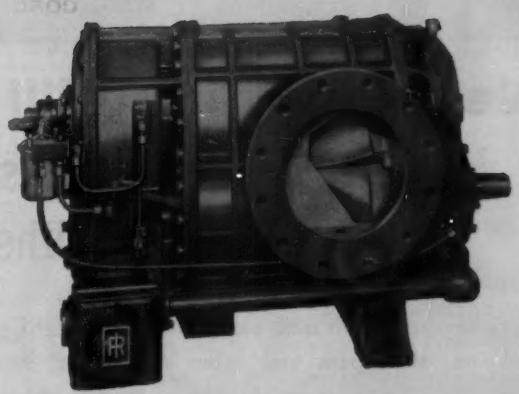
The rotors are synchronized by timing gears, encased in a separate, oil-tight compartment. Shaft seals between the compression chamber and atmosphere are simple labyrinth type as standard. Positive, mechanical type seals are also available. This is just one of several basic advantages of the Axi-compressor for compression or vacuum service. Ask your Ingersoll-Rand representative for complete information, or send today for a copy of Bulletin 11,001A.



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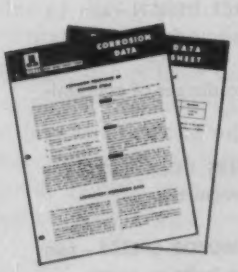
It is located at the Louisville, O., plant of J & L's Stainless and Strip Division. For complete information on the Division's flat rolled stainless products, write our Detroit sales office today.



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U.S.I. CHEMICAL NEWS

Sept. ★ A Series for Chemists and Executives of the Solvents and Chemical Consuming Industries ★ 1958

Aliphatic Dinitriles And Diamines Prepared From ISOSEBACIC® *Acid*

A new method of synthesizing aliphatic dinitriles and diamines — some of them believed to be new compositions of matter — is described in U.S. Patent 2,824,118, recently issued to U.S.I.

ISOSEBACIC acid is reacted with ammonia and/or urea or other nitrogen-containing compounds to form a mixture of C_{10} dinitriles. They are primarily sebaconitrile, α-ethylsubero-nitrile and α,α'-diethyladiponitrile.

The nitrile mixture can then be hydrogenated in the presence of ammonia and a catalyst to yield C_{10} diamines. They are a mixture of decamethylene diamine, 1,8-diamino-2-ethyloctane and 1,6-diamino-2,5-diethylhexane.

The dinitriles are considered valuable as chemical intermediates, and for solvents, lubricants, plasticizers and textile water repellants. The diamines should be useful in the synthesis of various types of polyamides — particularly fibers — and in plastics, rubbers, plasticizers, synthetic lubricants, polyurethanes and other products.

Nutritional Dystrophy Studies Show Lower Methionine in Blood

It has been reported that determinations of methionine in the blood of children with nutritional dystrophy average considerably below normal. In a study of whole blood from malnourished and normal boys, methionine content was found to average 73 mg. lower in the first group (331 ± 16 mg. as against 404 ± 16 mg. for the normal group). Determinations on the serum alone did not reveal a similar variation.

It was felt by the investigators that low values in the whole blood of the malnourished children might be due to hypochromic anemia prevalent in the group.

390 Million Nonfood Aerosols Sold in 1957

The Chemical Specialties Manufacturers Association estimates that 390 million nonfood aerosol units were produced in 1957, based on 339 million units reported in their survey and adjusted for companies not responding. Here's how the report looked, in millions of units:

Hair Sprays	94.4
Shaving Lather	50.9
Room Deodorants	41.9
Insect Sprays	41.5
Coatings	36.5
Colognes and Perfumes	17.9
Household Products Other Than Room Deodorants and Glass Cleaners	16.9
Personal Products Other Than Shaves, Hair Sprays, Colognes & Perfumes	12.3
Glass Cleaners	11.2
Miscellaneous	15.6

New Roles Seen for Ethanol in Medical & Pharmaceutical Fields

Recent Developments Include New Nerve Block Application, And Improvement of Ruminant Nutrition

Medical and biochemical research on ethyl alcohol — best known as a solvent — is constantly revealing new facets of its personality. It is evident that ethanol has *many* modes of action—physical, chemical and biological — that are important to the doctor, the nutritionist and the producer of pharmaceuticals.

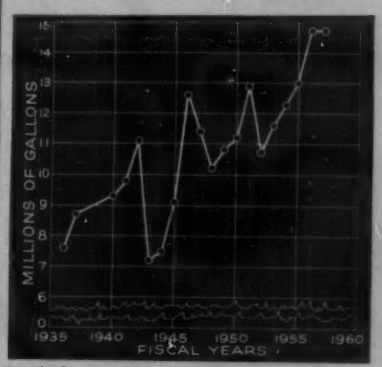
The practical use of ethanol in medicine as a nerve block agent is increasing. A few months ago a team of radiologists and neurosurgeons revealed a method of treating the painful facial *tic douloureux* by radiologically controlled injections of absolute alcohol. Forty-five patients so treated experienced immediate relief of symptoms, it was reported, although several had to be retreated, and one finally had to undergo the usual surgery.

New Function in Microbiology

Fermentation processes utilize several of ethanol's well-known modes of action—solvent, carbon source for yeast growth, and nutrient raw material for bacterial conversion into other chemicals.

And now, within the last year, a patented* novel use of ethanol in fermentation has begun to revolutionize the ruminant feed industry. It has been discovered that alcohol ingestion by cattle and sheep accelerates rumen microflora metabolism, by acting as a hydrogen donor. Ethanol has the unexpected property of maintaining a low oxidation-reduction potential in the rumen. This allows greater utilization of natural feeds rich in cellulose, and enables the micro-organisms in the rumen to make better use of nonprotein nitrogen materials such as urea. The microfloral cycle is

MORE



Graph shows consumption of specially denatured alcohol in pharmaceuticals and toiletries.

Sources: (a) STATISTICS ON THE USES OF SPECIALLY DENATURED ALCOHOL, Internal Revenue Service (data for 1936-1937 and 1940-1957). (b) ANNUAL REPORTS OF THE COMMISSIONER OF INTERNAL REVENUE, Internal Revenue Service (data for 1938 & 1939).

Heterocyclic, Homocyclic Systems Made by New Route

Research chemists have discovered that heterocyclics and homocyclics can be synthesized by an entirely new method. Potassium amide is reacted with the starting material to form a benzyne intermediate with a nucleophilic center. Nucleophilic means "seeking an electron-deficient group." In the presence of liquid ammonia, this center then adds intramolecularly to give a closed-ring compound.

Indane, indole, 2-phenylbenzothiazole, benzoxazole and phenothiazine have all been made by this new technique, and the research group believes it can be used to prepare many other hetero- and homocyclic compounds. Both five- and six-membered rings have been formed, all through intramolecular addition of nucleophilic sulfur, oxygen, nitrogen and carbon.

Stauffer's $TiCl_4$ Plant Bought by Mallory-Sharon

Stauffer Chemical Company's new 50 million pound-per-year titanium tetrachloride plant at Ashtabula, Ohio has been purchased by Mallory-Sharon Metals Corporation, which in turn is one-third owned by U.S.I. The new acquisition completes the company's integration of facilities for producing titanium — from ore to finished mill products.

New Method for Making Glycidyl Esters

The glycidyl esters — important as perfume and flavor ingredients, and in vinyl plasticizers, stabilizers and resin intermediates — can now be synthesized by using sodium hydride in oil as the condensation reagent in the Darzen condensation reaction.

When employed together with a ketone and a chloroacetate acid ester, NaH in oil is reported to give excellent yields in short reaction times at room temperature, with little or no side reaction.

NaH in oil is a 50% dispersion of 2-25 micron particle size crystals in an inert white mineral oil. It is handled as a solid which can be fed directly into reaction vessels either mechanically or by hand.

NaH in oil is prepared from dispersed sodium and hydrogen at 190-225°C. Its preparation is described in U.S.I.'s brochure "Sodium Dispersions," available on request.

CONTINUED

Ethanol

accelerated, thus increasing the daily rate of protein synthesis and cellulose digestion.

It is thought that this new role for ethanol may find application in other fermentation processes allied with the manufacture of pharmaceuticals and biologicals.

Ethanol Is a Surfactant

Ethyl alcohol is being used as an antifoam to relieve pulmonary edema in humans which sometimes occurs immediately after surgery. Under such conditions foaming in the lungs interferes with oxygenation. Inhalation of 95% alcohol vapor modifies the surface tension of the fluid and reduces the amount of foam in the lung. It is reported to produce immediate and dramatic recovery in most medical cases.

Protective Action in Body

Data is continually being compiled on the action of ethanol as a protective agent in the body. Organophosphate compounds, such as chemical warfare nerve gases and some agricultural insecticides, are known to act by inhibiting the formation of serum cholinesterase by the organism. It has recently been discovered, that ethanol protects against this inhibiting action.

Animal experiments have shown that preadministration of ethanol gives considerable protection against radiation sickness.

Role in Body Metabolism

In the human body, moderate doses of ethyl alcohol have been found to exert a protein-sparing action—improving protein storage and growth. And it has been reported that a positive nitrogen balance is more easily maintained in human convalescence when glucose and amino acids are supplemented with ethanol. Studies on animals show that ethanol also helps mobilize vitamin A from storage depots in the body.

The roles of ethyl alcohol as a vasodilator, as a stimulant, and as an antiseptic and disinfectant are well known, but should be mentioned here to round out the perspective on this U.S.I.-produced compound — one of the most versatile and valuable chemicals the medical and pharmaceutical fields have at their disposal today.

**U.S. Patent 2,808,332 — Anderson and Rapp*

U.S.I. Tank Car Domes Now Color-Coded for Product

The entire U.S.I. fleet of 900 tank cars is being repainted black on light gray, with the traditional U.S.I. oval in black and red. Inherent in the new design is a color-coding system that immediately identifies the type of service for which tank cars are used. Domes of the tank cars are painted any of the following identifying colors:

Solid Domes
- General Service (alcohol, etc.) ..... White
- Ethyl Ether ..... Light Blue
- Chlorine ..... Light Green
- Ammonia ..... Bright Yellow
- Sulphuric Acid ..... Black
- Phosphatic Fertilizer Solution ..... Bright Orange
- Nitrogen Fertilizer Solution .... Bright Red
- Caustic Soda Cars ..... Maroon
- Metallic Sodium ..... Gray

Black Domes with 4 Inch Color Stripes
- Ethyl Chloride ..... Black with Orange
- Olefin ..... Black with Yellow
- Miscellaneous gasoline, waste material ..... Black with Red

This new color-coding system provides U.S.I. with a double check — an at-a-glance opportunity to pick up errors before cars reach the loading rack.

Black, light gray and color-coded dome combine to give new look to U.S.I. tank car fleet. Overall design was chosen to give company identity, dome color to give product identity. Here a newly painted U.S.I. Alcohol tank car with identifying white dome is loaded at Tuscola, Ill.

TECHNICAL DEVELOPMENTS

Information about manufacturers of these items may be obtained by writing U.S.I.

N-meta-tolyl phthalamic acid has been discovered to increase plant yields by reducing shock and stress of heat, cold, long rains and drought. Material has been test-sprayed on limas, cotton, cherry trees. **No. 1390**

New booklet on polyethylene film, coatings and molded items for packaging field illustrates advantages of material in terms of economy, sales appeal, protection of product and convenience. **No. 1391**

Zone-melting purifier for organic compounds now on market. Claimed to permit preparation of hyperpure solids in laboratory through slow travel of ring heater up along glass tube containing solid. Impurities concentrate at top. **No. 1392**

New insect repellent, diethyltoluamide, is said to be most effective ever developed for mosquitos, fleas, ticks, chiggers, deer flies. Product now being made with 95% minimum meta isomer content. **No. 1393**

Rare books on science and medicine which can be purchased are listed in new catalog which includes 258 works, alphabetically by author. Catalog covers only a portion of books available. Lists works printed from 1485 to 1929. **No. 1394**

A new aluminum hydroxide-magnesium carbonate co-precipitate dried gel is being sold which, it is claimed, will permit antacid producers to market tablets and powders with the same therapeutic value as the usual liquids. **No. 1395**

Series of ultrasonic units — mass-produced, low-cost, laboratory-size — has been developed for cleaning small delicate parts or assemblies, glassware, apparatus. Also suggested for biological, medical, chemical studies. **No. 1396**

2-Carbethoxycyclopentanone is now available commercially for pharmaceutical and fine chemical applications. Is precursor for many 2-substituted cyclopentanones. Enters into variety of reactions typical of beta-ketoesters. **No. 1397**

3-Sulfolene and some derivatives can now be obtained in research quantities. It is a controlled source of pure sulfur dioxide. As an intermediate, it reacts with chlorine, water, ammonia, alcohol and mercaptans. **No. 1398**

Odor-metering apparatus and techniques for its application to industrial odor-control problems are described in new 4-page brochure. Odor meter measures subjective impressions, must be operated by experienced personnel. **No. 1399**

PRODUCTS OF U.S.I.

ALCOHOLS

Ethyl Alcohol (Ethanol): Specially denatured — all regular and anhydrous formulas. Completely denatured — All regular formulas for industrial use, anti-freeze. Pure alcohol—USP 190°—Absolute, N.F., taxfree, taxpaid.

Proprietary Denatured Alcohol Solvents: SOLOX® — General-purpose. FILMEX® — Special, authorized for certain industries. ANSOL® M — Anhydrous, special blend for lacquers, resins, etc. ANSOL® PR—Anhydrous, special blend with higher ester content and solvency for lacquers, resins, etc.

OTHER PRODUCTS

Organic Solvents and Intermediates: Normal Butyl Alcohol, Amyl Alcohol, Fusel Oil, Ethyl Acetate, Normal Butyl Acetate, Diethyl Carbonate, DIATOL®, Diethyl Oxalate, Ethyl Ether, Acetone, Acetoacetanilide, Acetoacet-Ortho-Chloranilide, Acetoacet-Ortho-Toluidide, Ethyl Acetoacetate, Ethyl Benzoylacetate, Ethyl Chloroformate, Ethylene, Ethyl Sodium Oxalacetate, Sodium Ethylate, ISOSEBACIC® Acid, Sebacic Acid, Urethan U.S.P. (Ethyl Carbamate), Riboflavin U.S.P., Pelargonic Acid, and 2-Ethyl Heptanoic Acid.

PETROTHENE® Polyethylene Resins

Pharmaceutical Products: DL-Methionine, N-Acetyl-DL-Methionine, Urethan USP, Riboflavin USP, Intermediates.

Heavy Chemicals: Anhydrous Ammonia, Ammonium Nitrate, Nitric Acid, Nitrogen Fertilizer Solutions, Phosphatic Fertilizer Solution, Sulfuric Acid, Caustic Soda, Chlorine, Metallic Sodium, Sodium Peroxide, Sodium Sulfite, Sodium Sulfate.

Animal Feed Products: Antibiotic Feed Supplements, BHT Products (Antioxidant), Calcium Pantothenate, Choline Chloride, CURBAY B-G®, Special Liquid CURBAY, VACATONE®, Menadione (Vitamin K_3), DL-Methionine, MOREA® Premix, Niacin USP, Riboflavin Products, Special Mixes, U.S.I. Permadry, Vitamin B_{12} Feed Supplements, Vitamin D_3, Vitamin E Products, Vitamin E and BHT Products.

U.S.I. INDUSTRIAL CHEMICALS CO.
Division of National Distillers and Chemical Corporation
99 Park Avenue, New York 16, N. Y.

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Be on the SAFE side and cut handling costs doing it

WITH ALLIS-CHALMERS LIFT TRUCKS

Any way you look at it, Allis-Chalmers lift trucks are built to *produce* and *protect*. Ask any user about their performance . . . how they out-maneuver . . . how you can count on them for long life with low maintenance.

Then check on the many ways they protect men and equipment. Note their sure-footed stability on steep grades . . . strength from frame to mast . . . freedom from obstructions in the operator's compartment . . . location of the fuel tank—away from the engine.

For hazardous areas play it REAL SAFE with special safety trucks

Allis-Chalmers GS (gasoline safety), LPS (LP gas safety) and DS (diesel safety) Trucks bear the Underwriters' Laboratories inspection seal for working in areas where there are flammable liquids or gases, combustible dusts or ignitible fibers. This type of operation requires many extra precautions, including starting motor and instrument panel that are totally enclosed, battery guard covered with asbestos and manual push-pull knob that cuts out electric system.

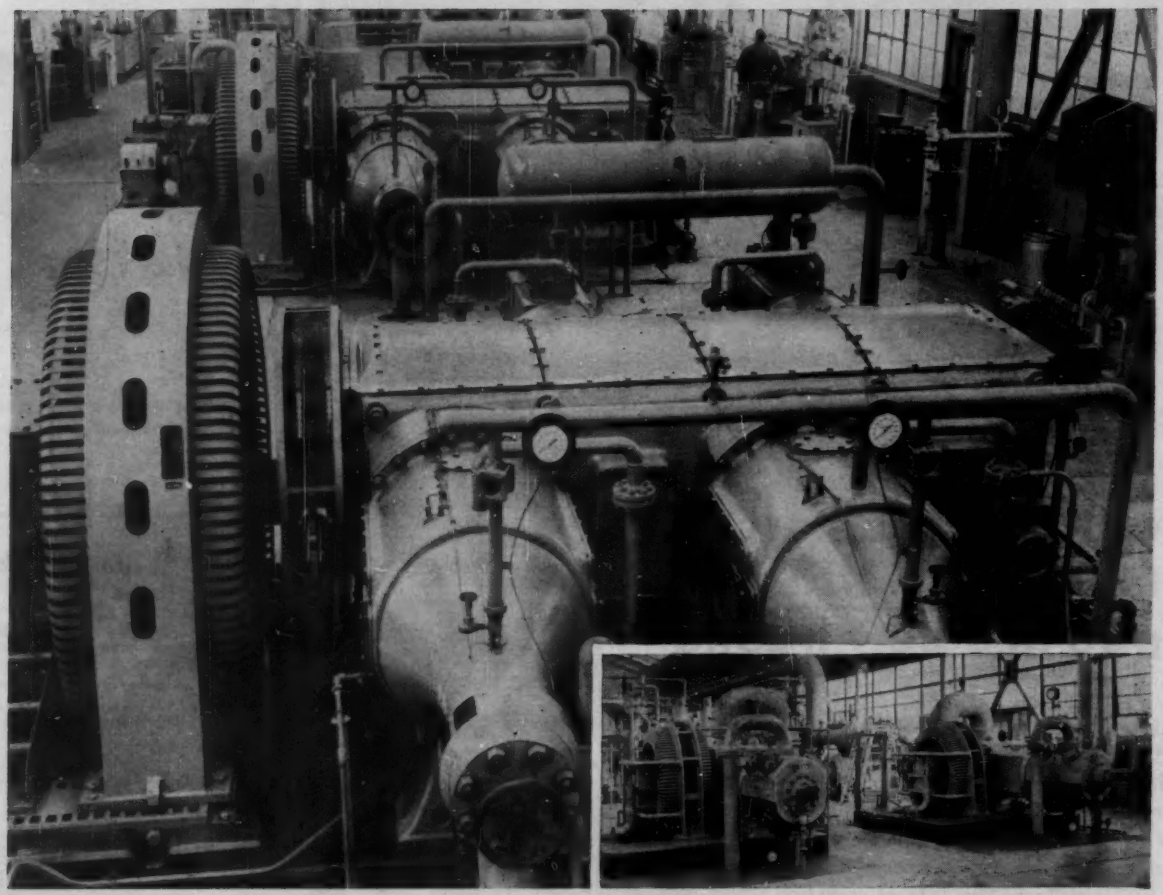
Allis-Chalmers DX Safety Diesel Lift Trucks were developed to provide exceptional protection against explosions. The starter is hydraulic, gauges are mechanical, water manifold and muffler reduce temperature of usually hot-surfaces and quench exhaust sparks. Tires are grounded, forks are spark-proof bronze alloy.

Accepted By
MILL MUTUAL
FIRE PREVENTION BUREAU

No matter what the job, your Allis-Chalmers material handling dealer can show you how you can have the best in both production and protection. Allis-Chalmers, Milwaukee 1, Wisconsin.

EH-85

ALLIS-CHALMERS



In Ammonia Service for U.S.I....

high efficiency Cooper-Bessemer Compressors

This installation at the Tuscola, Illinois plant of U. S. Industrial Chemical Co., a division of National Distillers and Chemical Corp., is typical of the many processing plants using reliable Cooper-Bessemer compressors.

Here, two 4-cylinder JM compressors, each rated 1500 hp, handle compression of synthesis gas; and two 2-cylinder FM compressors, each rated 300 hp, handle the compression of ammonia.

These modern, natural force balance Cooper-Bessemers retain the long-life qualities of much larger slow speed units. The M-Line is exceptionally compact without sacrificing accessibility or ruggedness. They conserve valuable space, reduce over-all installation time, and require less investment in foundations and piping.

Available from 200 to 6000 horsepower, each M-Line compressor unit is engineered to meet specific requirements with extreme efficiency and at the lowest possible cost. The nearest Cooper - Bessemer office will gladly furnish detailed information.

BRANCH OFFICES: Grove City • New York • Chicago • Washington • San Francisco • Los Angeles • Houston • Dallas • Odessa • Minneapolis • New Orleans • Shreveport

SUBSIDIARIES: COOPER-BESSEMER OF CANADA, LTD. . . . Edmonton • Calgary • Toronto • Halifax
COOPER-BESSEMER INTERNATIONAL CORPORATION . . . New York • Caracas • Mexico City

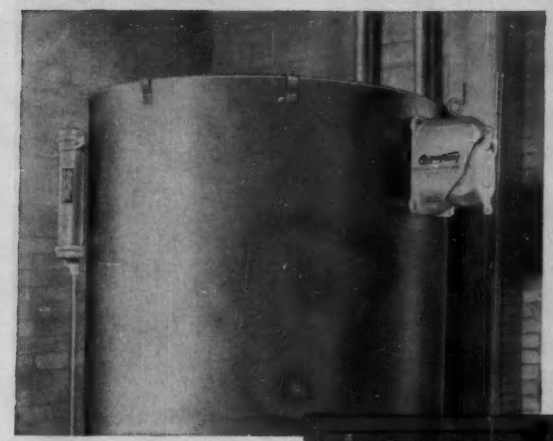
Cooper/Bessemer

GENERAL OFFICES: MOUNT VERNON, OHIO

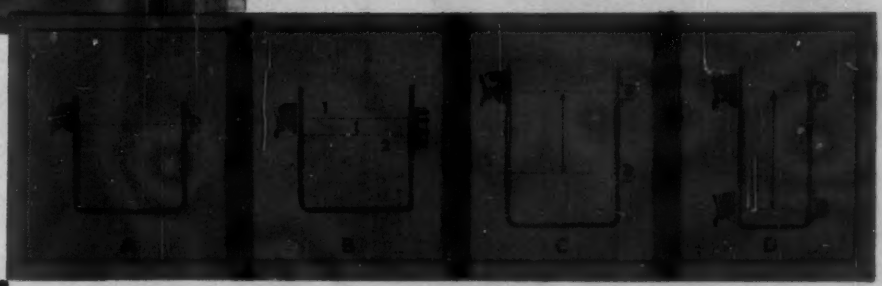
ENGINES: GAS - DIESEL - GAS-DIESEL
COMPRESSORS: RECIPROCATING AND CENTRIFUGAL
ENGINE OR MOTOR DRIVEN

AccuRay... TANK OR BIN LEVEL SYSTEMS

A Level Detector-Controller System Designed to your Requirements



Adaptable to four methods of operation, AccuRay's Detector-Controller offers outstanding advantages over float-level type control systems. It is easily installed and maintained and is priced from only $465.00. The Detector-Controller utilizes two units—a radiation source housing, which provides more than adequate shielding, and a detector. Both units are mounted externally . . . thus are free from fouling by process materials. Accuracies can be maintained to ± ⅛" as a high or low level alarm. The source housing can be pivoted to provide radiation shielding during work inside the tank. Design of the instrument is in accordance with accepted standards for both explosion-proof and weatherproof operations.



another AccuRay advancement for process control

AccuRay® is a registered trademark of Industrial Nucleonics Corporation

High or Low Level Control . . . The detector is mounted diametrically opposite the radiation source. When the material moves above the level of the detector, the radiation is cut off, causing the output relay to change position. When the material drops below the level, the output relay is thrown to its opposite position. **Narrow Band Control** . . . The detector is mounted vertically along the tank, resulting in narrow band control. When the material moves above position (1), a signal is provided from the output relay. The opposite signal is provided when the material drops below level (2). **Wide Band Control** . . . A single source unit is teamed with two detector elements. The material can be controlled within the distance separating the high and low level detectors. The signal can also be used to provide a combination high-low level alarm system. **Extra-Wide Band Control** . . . Two source units are teamed with two detectors in cases where the vertical separation desired is large relative to the tank diameter. This system can also provide a high or low level alarm.

Also available is the AccuRay continuous tank or bin level measurement system . . . Continuous indication of the level of material is read directly from an indicator or recorder. The system may also be instrumented to provide automatic control of level.

Please send complete details on AccuRay Tank or Bin Level Detector-Controllers.

Name _____ Title _____

Company _____

Street _____

City _____ Zone _____ State _____

Application _____

_____

Industrial Nucleonics
CORPORATION
1149 Chesapeake Ave., Columbus 12, Ohio

The WORLD'S LARGEST Manufacturer of Nucleonic Industrial Process Control Systems

Operator checks Ni-Resist pump at Pennsalt Chemical's Portland plant. This particular unit was manufactured by A. R. Wilfley & Sons, Inc. of Denver, Colorado, and pumps caustic at a concentration of 50%. The Duriron Company, Inc. of Dayton, Ohio, also supplied Ni-Resist pumps for the plant.

Ni-Resist pump...eleven years caustic service behind it...years of service ahead

Ni-Resist* pumps have been in caustic service at Pennsalt Chemicals Corporation, the Portland, Oregon plant of the Pennsalt of Washington Division, for eleven years . . .

Eleven years of pumping cell liquor containing 9.3% caustic soda at 170°F to evaporator feed storage . . .

Eleven years of pumping 50% caustic at 80-90°F to storage after concentration . . .

Eleven years of pumping 50% caustic from storage into tanks for shipment.

In regular caustic service, Type 2 Ni-Resist iron offers you proven corrosion resistance. When corrosion resistance *plus* thermal shock resistance are needed . . . Type 3 Ni-Resist iron does the job.

Equipment parts made of Ni-Resist cast iron stand up to alkalies, acids, salts. They resist erosion, protect product purity. What's more, you have eight Ni-Resist irons to choose from. Each one is a proven engineering material with one or more outstanding properties – pressure tightness . . . extra-low thermal expansion . . . high stain resistance.

You'll find the answer to your corrosion problem in this family of high-nickel irons. Get all the details. Write for "Engineering Properties and Applications of Ni-Resist."

*Registered trademark

The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall Street New York 5, N.Y.

INCO NICKEL

NICKEL MAKES ALLOYS PERFORM BETTER LONGER

ALLEN-BRADLEY | Cutting Costs in the Chemical Industry

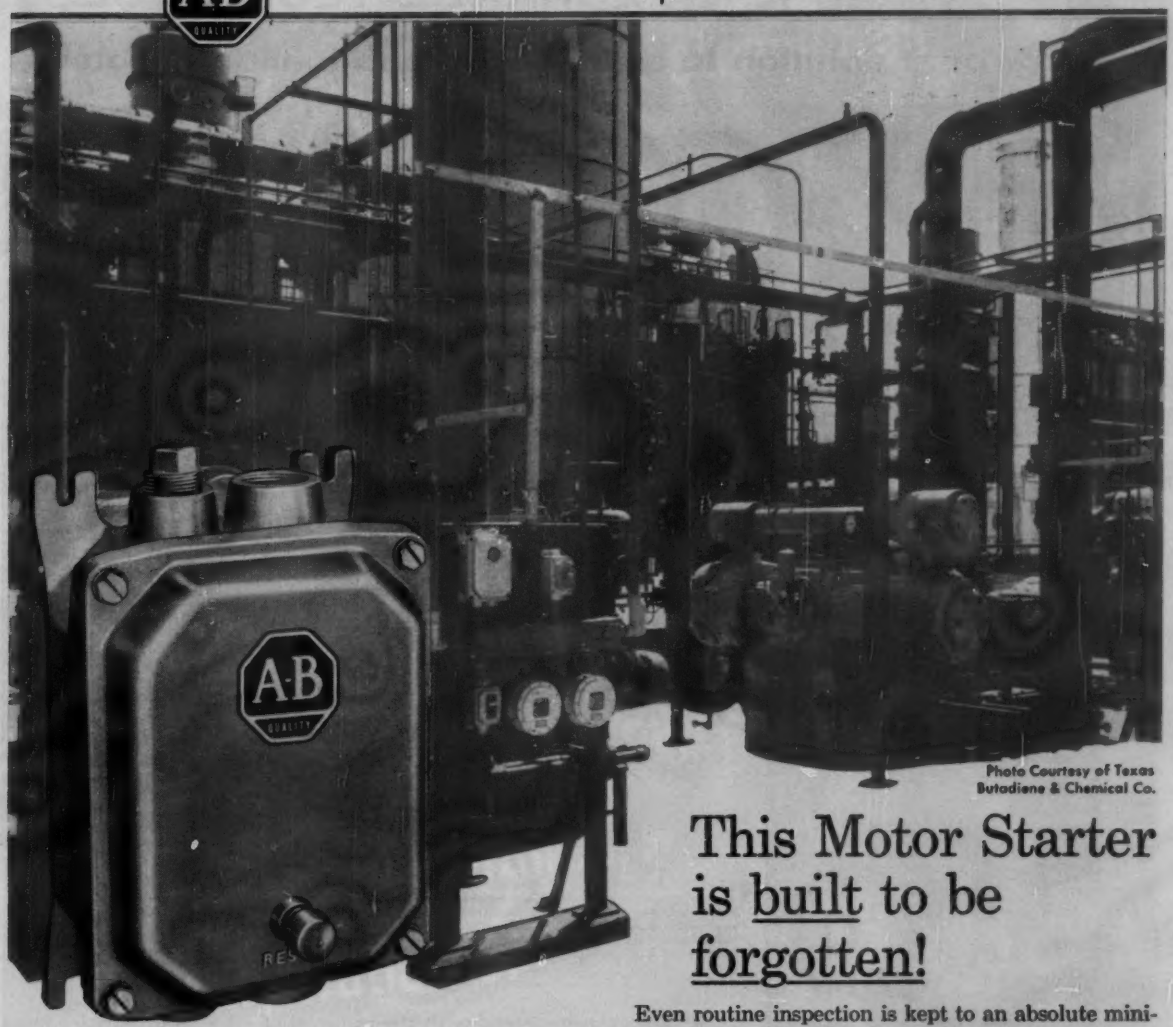


Photo Courtesy of Texas Butadiene & Chemical Co.

Bulletin 709 Size 1 Solenoid Starter in NEMA Type 4 watertight enclosure

This Motor Starter is built to be forgotten!

Even routine inspection is kept to an absolute minimum with Allen-Bradley motor starters . . . an especially important saving when your installation requires bolted covers, as used with watertight and explosion-proof enclosures.

It's the simple contact mechanism—with only ONE moving part—that enables Allen-Bradley solenoid starters to operate over long periods without attention. With no bearings to corrode or stick . . . no flexible jumpers to break . . . you are assured *millions* of trouble free operations. In addition, there are double break, silver alloy contacts that never need servicing of any kind. And permanently accurate thermal overload relays protect motors against burnout, irrespective of time or atmospheric conditions.

Specify Allen-Bradley quality controls for *all* your installations . . . and you'll save on maintenance.

NEMA 9 For Hazardous Dust

NEMA 7 For Hazardous Gas Locations

NEMA 8 For Corrosive Hazardous Gas

NEMA 11 Corrosion-proof

Allen-Bradley Bulletin 709 across-the-line solenoid starters are made in eight sizes with maximum ratings to 300 hp, 220 volts; 600 hp, 440-550 volts.

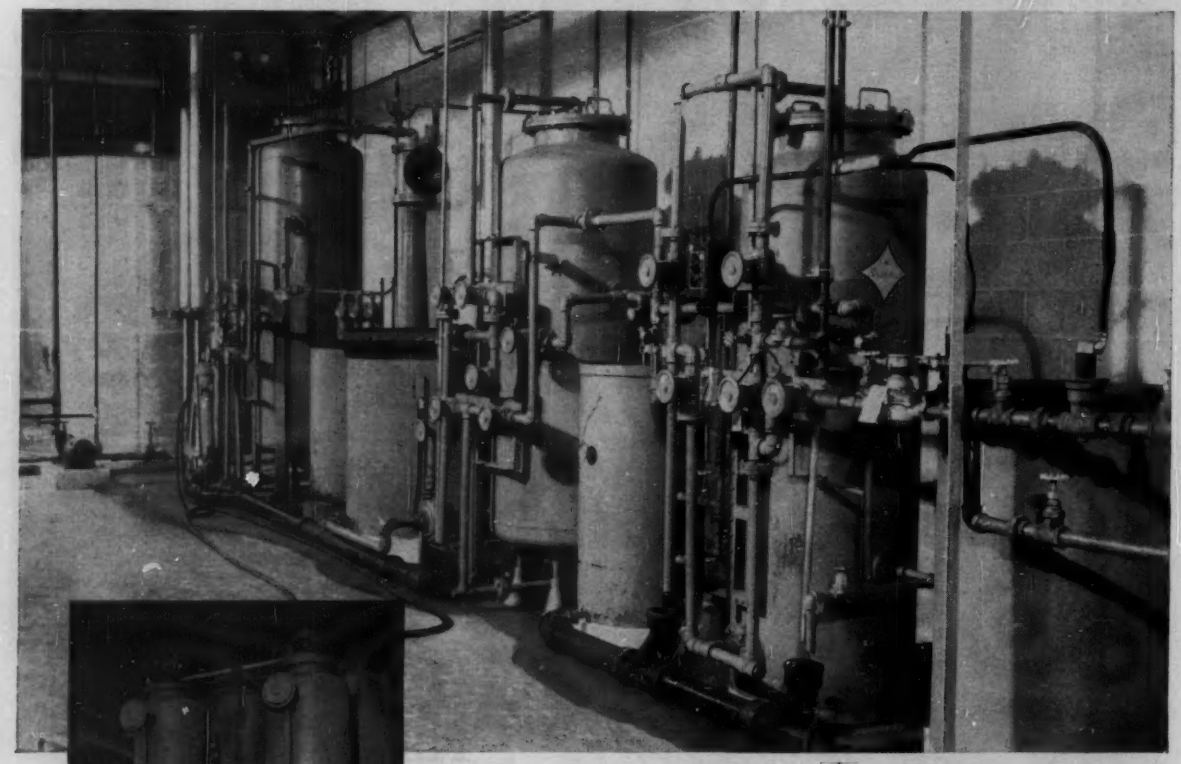
ALLEN-BRADLEY CO.
MOTOR CONTROL
QUALITY

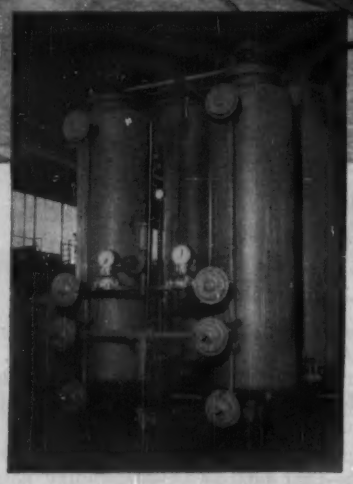
Allen-Bradley Co., 1337 S. First St. Milwaukee 4, Wis.

In Canada: Allen-Bradley Canada Ltd. Galt, Ont.

INDUSTRIAL ION EXCHANGE TECHNIQUES

. . . low cost solution to specialized purification problems





EXAMPLE 1: *Purification of Formaldehyde.* Specialized anion exchange technique removes formic acid from formaldehyde. This *Industrial* semi-automatic, dual unit also "up-grades" water white formaldehyde for resin manufacture—yields final resins with resistance to off-color blush or bloom.

EXAMPLE 2: *Chemical preparation.* An *Industrial* mixed-bed ion exchange unit used for removal of sodium formate and formic acid from an organic polyhydric alcohol intermediate. Process facilitates subsequent purification by evaporation.

• Are you concerned with the removal of mineral impurities from solvent solutions—chemical intermediates—purification of glycerine—or other materials which usually require tedious, costly processing by alternate methods? If you are faced with the problem of purifying such materials, and if they contain even traces of moisture, then *Industrial*-engineered ion exchange techniques and equipment may provide a complete and inexpensive answer to your problem.

The two installations of *Industrial* ion exchange equipment illustrated here are typical of the many specialized applications of ion exchange developed and engineered by *Industrial* to meet specific chemical process industry requirements.

To evaluate the possibilities of these techniques to solve your purification problems, and to obtain an analytical study, consult *Industrial*, soon.

For general information covering *Industrial* Ion Exchange equipment, write for a copy of BULLETIN 200.

INDUSTRIAL

C-158

INDUSTRIAL FILTER & PUMP MFG. CO.
5918 Ogden Avenue, Chicago 50, Illinois

PRESSURE FILTERS ◆ ION & HEAT EXCHANGERS ◆ WASTE-TREATING EQUIPMENT

The Yarway Impulse* steam trap
is the only steam trap that continually
senses condensate conditions
in the line ahead of the trap,
and discharges this condensate
as soon as it forms.

Result—higher temperatures,
steadier temperatures,
peak operation of
steam heated equipment
at all times.

* A COMPLETE LINE OF STEAM TRAPS, ALL OPERATING ON A PROVEN THERMODYNAMIC PRINCIPLE.

Actual size, ¾" trap

YARWAY impulse®

Manufactured by YARNALL-WARING CO., 137 Mermaid Avenue, Philadelphia 18, Pa.
Stocked and sold by 270 Industrial Distributors.
Write for free bulletin "The Why and How of Steam Trapping."

OPTIMUM DESIGN...

of YUBA HEAT EXCHANGERS achieved by COMPUTER SYSTEM

Into Yuba's Central Computer System go the temperatures and pressures your heat exchangers must handle, flow quantities and fluid properties, tube layout, allowable pressure drop, and nozzle connections.

Out comes the number in series, shell size, minimum number of segmental baffles, optimum number of tube passes, calculated pressure drop, heat transfer rate on both shell and tube sides, and the corrected LMTD. Elapsed time: 15-20 minutes with the computer as compared to days with the slide rule.

No guesswork! Optimum results with absolute accuracy. Also...we can extract from the Yuba Computer System all kinds of alternates for you: alternate flow quantities, alternate temperatures, and alternate tube construction (fin or bare). This central computer system is used by all Yuba divisions manufacturing heat exchangers.

YUBA HEAT TRANSFER DIVISION, Homestdale, Pa.; ADSCO DIVISION, Buffalo, N. Y., and YUBA MANUFACTURING DIVISION, Benicia, Calif.

YUBA CONSOLIDATED INDUSTRIES, INC.

OTHER YUBA PRODUCTS FOR THE CHEMICAL AND PETROLEUM INDUSTRIES.

YUBA

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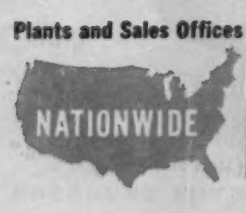
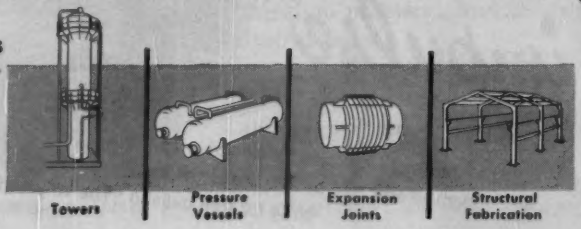
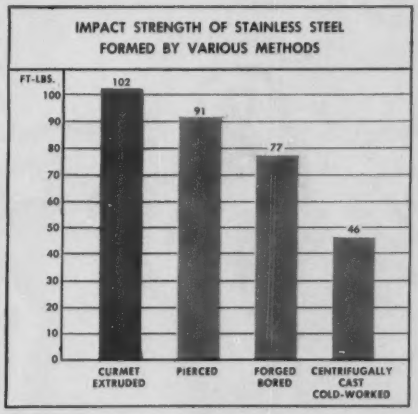




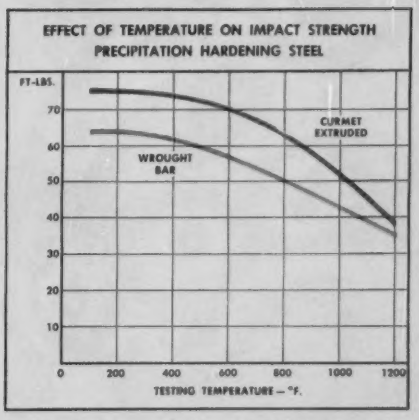
EXTRUSION • CASTING • FORGING • FABRICATION

CURMET

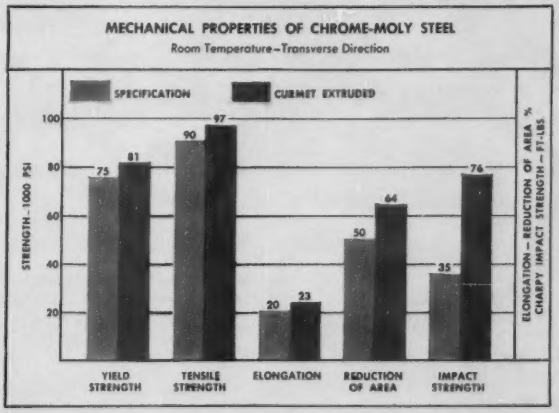
For Superior Resistance to **IMPACT** *Stresses*



Impact strengths (Charpy) at 300° F. below zero. Curmet extruded Grade 304 stainless steel shows strength from 13% to 120% higher than the same alloy processed by other methods. Improvement in impact strength is consistent up to 1200° F.



Impact resistance of strength-at-high-temperature steels (A-286 in this case) is substantially greater when Curmet processed. The Curmet extrusion tests consistently 10 ft.-lbs. better than the usual wrought product.



"Above specification" characterizes the physical properties of all Curmet products. But impact strength is particularly noteworthy—more than 100% over specification—as shown by these test results on heat treated Grade P-22 steel.

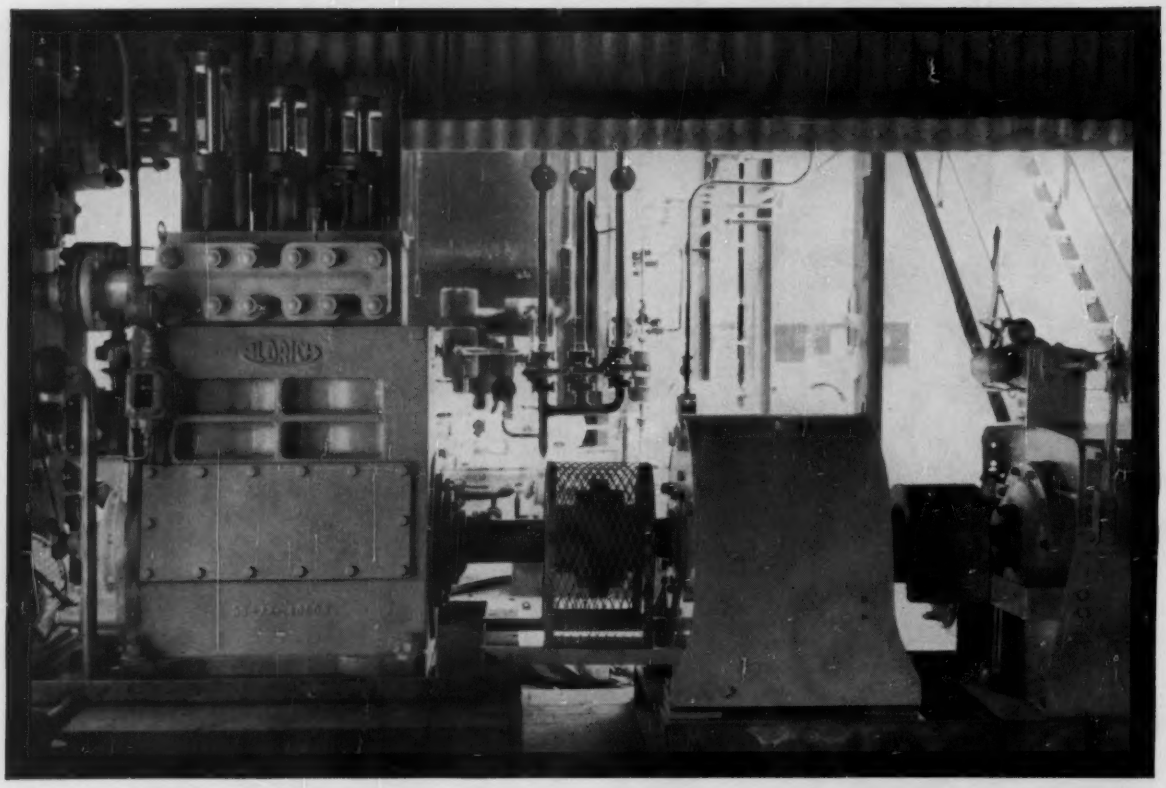
Curmet Processing Adds to Alloy Performance

This is one of many outstanding achievements in metals from the Curmet plants and laboratories. As the frontiers of metallurgy advance under the pressure of more critical operating conditions, Curmet processing utilizes skills and knowledge, based creatively on wide experience with high performance metals, to give added integrity to new alloys.

FOR FULL INFORMATION, WRITE TO:

METALS PROCESSING DIVISION
760 Northland Avenue

CURTISS-WRIGHT CORPORATION
Buffalo 15, New York



THE PRESSURES ARE HIGH...THE LIQUIDS CORROSIVE...THE PUMPS ARE ALDRICH...

At the Houston plant of Rohm & Haas Co., this Aldrich pump alternately introduces caustic and brine into one phase of the acrylate process for producing acrylic monomers.

The problem: Handle highly corrosive liquids at 3000 psi in a continuous process and *not* have severe maintenance problems.

What Rohm & Haas did about it. Company engineers specified Aldrich 1⅝" x 5" stroke Triplex Pumps for three reasons.

1. Compact, heavy-duty construction makes Aldrich pumps ideal for high pressure service.

2. Aldrich pumps are designed for easy maintenance. Fluid-end sectionalization permits quick removal of valves for inspection or replacement. No special tools are required.

3. Aldrich engineers can draw upon a vast store of experience when it comes to selecting the right materials for any pumping job. In this case, the entire fluid end . . . working barrel, suction and discharge manifolds . . . are forged Monel. Valve seats are Haynes Stellite. Valves and plungers are K Monel.

Results: According to the Plant Manager of the Houston plant, "maintenance requirements have decreased and pumping production improved. These Aldrich pumps lend themselves to easy maintenance."

How Aldrich can help you. Solving pumping problems like this requires specialized engineering skills and experience. We have those skills, and our experience comes from years of working with the chemical industry. We welcome the opportunity to discuss your specific problems . . . no matter what the liquid or how high the pressures. Aldrich Pump Company, 3 Gordon Street, Allentown, Pa.

the toughest pumping problems go to ALDRICH

Center lining of welding-neck and slip-on flanges

ANOTHER FIRST IN THE INDUSTRY-ANOTHER FIRST FROM OTM

A special machine developed, patented and now used exclusively by OTM to center-line each welding-neck and slip-on flange was put into operation on June 1, 1958. Center lining assures correct welding angle through correct matching of bolt holes. Center lining of flanges at the OTM plant, at no extra cost to fabricators, means a greater saving in labor time and production expense!
Again, OTM Blue Ribbon Products, with the most comprehensive written guarantee in the industry, and . . .

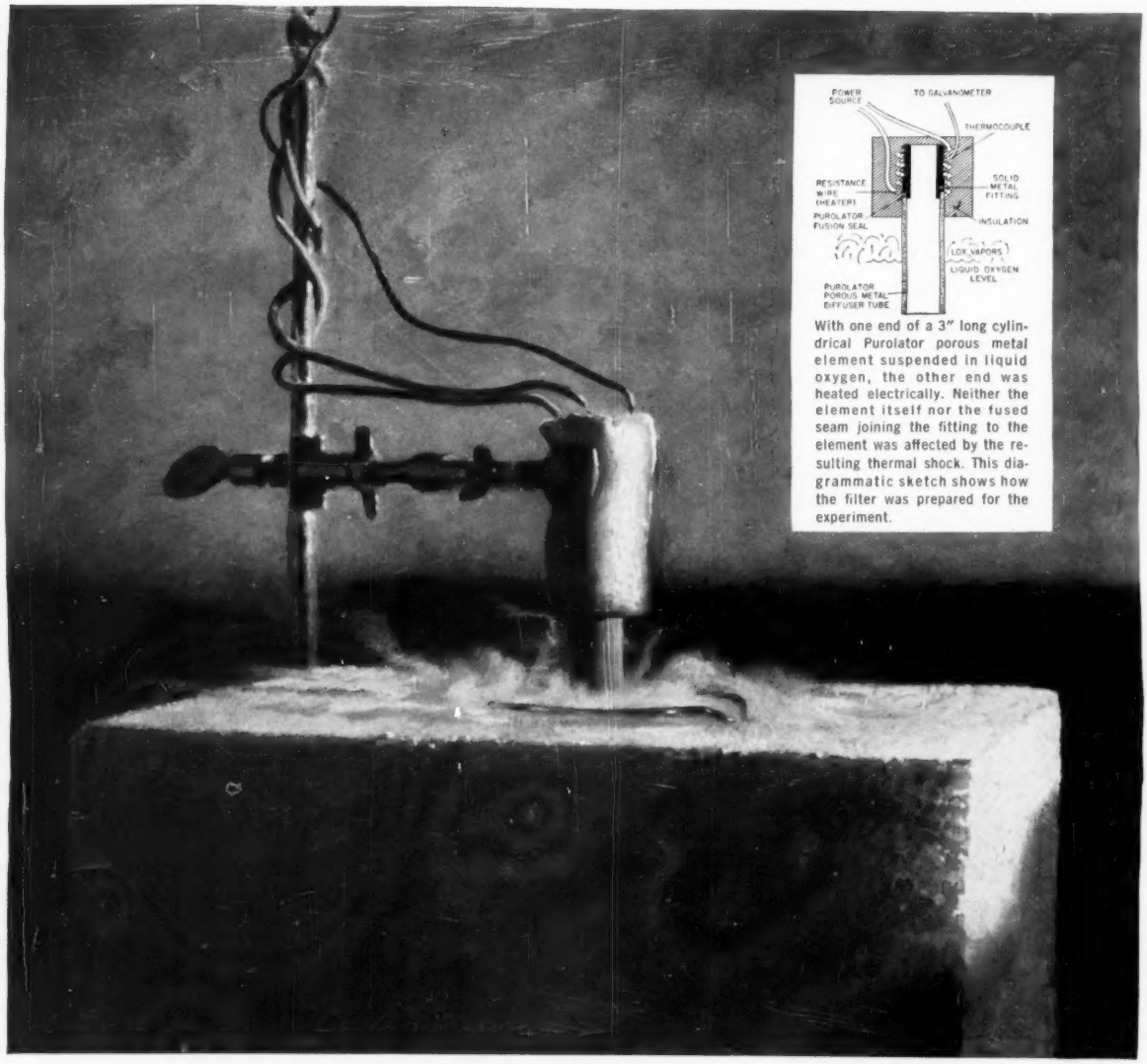
OTM FLANGES PROVE THE ECONOMY OF PERFECTION

OTM CORPORATION

P.O. Box 19296 Houston 24, Texas UN 2-6843

Odessa — Dallas — New York — Tulsa — Baton Rouge — Los Angeles

A-4-58



With one end of a 3" long cylindrical Purolator porous metal element suspended in liquid oxygen, the other end was heated electrically. Neither the element itself nor the fused seam joining the fitting to the element was affected by the resulting thermal shock. This diagrammatic sketch shows how the filter was prepared for the experiment.

Filters for extreme conditions . . .

THERMAL SHOCK

Purolator metal filter media can take it

How much thermal shock can a filter withstand?

In a recent series of experiments, various samples of Purolator metal filter media stood up under temperature gradients, across short lengths, of up to 500°F...and could have taken more. There was no effect on filter efficiency.

Thermal shock is only one of the difficult operating problems Purolator's staff of "Q" and "L" cleared-filtration experts handle regularly. They can design and produce the exact filter needed to remove any known contaminant from any known fluid under any operating conditions. They have produced filters and separators to operate within the following wide ranges of conditions:

TEMPERATURES: from —420° to 1200°F.

PRESSURES: from a nearly perfect vacuum to 6,000 psi.

RATES OF FLOW: from drop by drop to thousands of GPM.

DEGREES OF FILTRATION: from submicronic to 700 microns (in various media).

No other filter manufacturer can offer such complete services to handle so wide a range of tough operating conditions. These brochures outline what Purolator can do for you, or, if you have an urgent filtration problem, call Jules Kovacs, Vice President in charge of Technical Sales... or send him the details of your application.

Filtration For Every Known Fluid

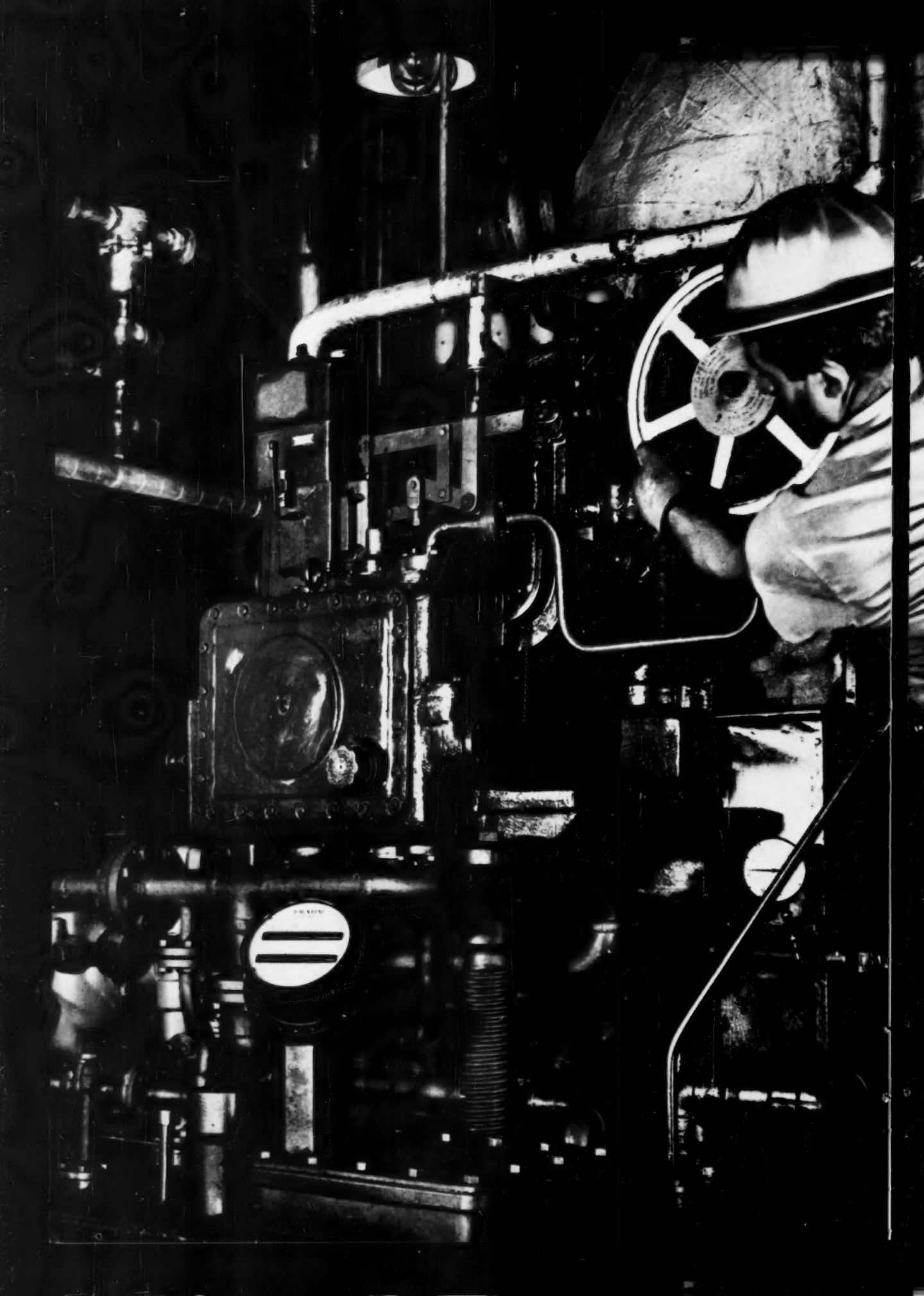
PUROLATOR

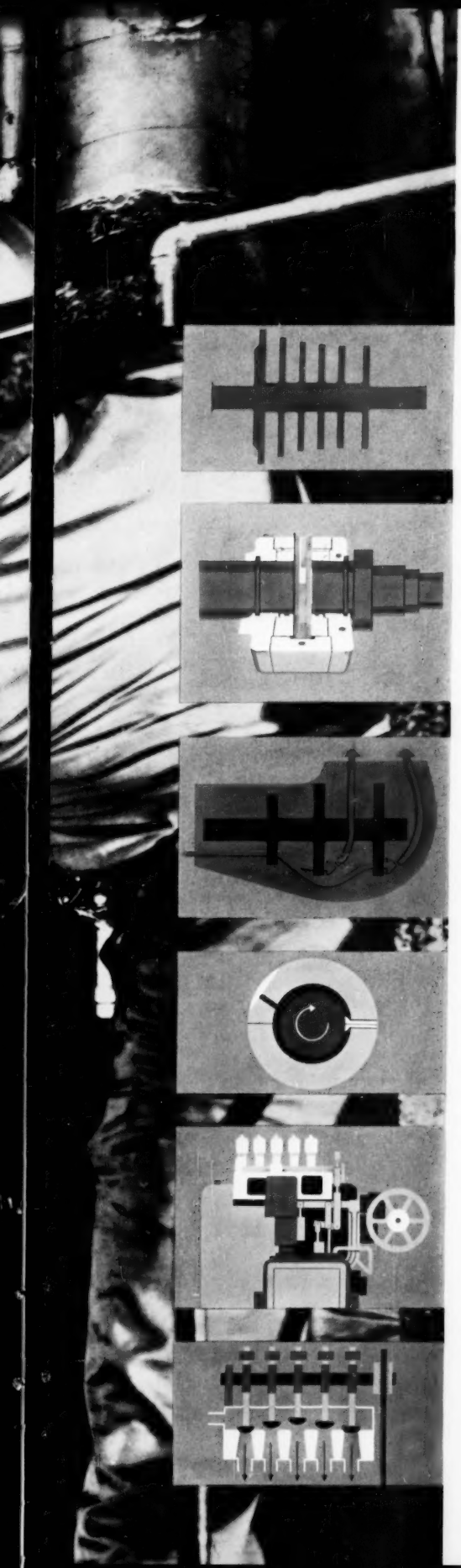
PRODUCTS, INC.

RAHWAY, NEW JERSEY AND TORONTO, ONTARIO, CANADA

HOW TO SAVE MONEY BY SPENDING IT!

PAY EXTRA NOW FOR 6 BASIC RELIABILITY FEATURES OF WORTHINGTON HIGH-SPEED TURBINES AND AVOID THE EXCESSIVE COSTS OF DOWN-TIME LATER





Worthington High-Speed Turbines cost more to build, are used more, are worth more

(these 6 reliability facts are some of the reasons why)

Reliability Fact #1

SOLID ROTORS keep wheel stresses well within safety margins. Where needed, wheels forged integral with the shaft are used to meet the demands of modern high speeds. Solid rotor construction, a sure method of holding wheels on the shaft, provides a more rugged conservative design. Solid rotor also decreases length of turbine, thus simplifying critical speed problems and adding to efficiency.

Reliability Fact #2

KINGSBURY-TYPE THRUST BEARINGS withstand heavy thrust loads with small friction loss and low rate of wear. Bearings have babbitted surfaced multi-segment shoes that pivot on hardened buttons. This pivoting action forms a wedge-shaped oil film between the rotating thrust collar and the shoe bearing surface. This has a cushioning effect in case of unusual shock loads in either direction. The thrust load is automatically distributed equally to the several shoes thereby maintaining internal alignment as well as holding the rotor in its axial position.

Reliability Fact #3

DOUBLE-FLOW exhaust construction on Worthington turbines reduces operating stress and increases efficiency in the handling of large volumes of steam at high speeds. Steam is divided ahead of the last stage and directed through separate rows of revolving blades before leaving via a common exhaust. Double-flow exhaust construction allows reduction in last-stage wheel size and blade length, which reduces wheel and blade stress and makes possible a simplified blade design. This permits improved nozzling with consequent efficiency increase.

Reliability Fact #4

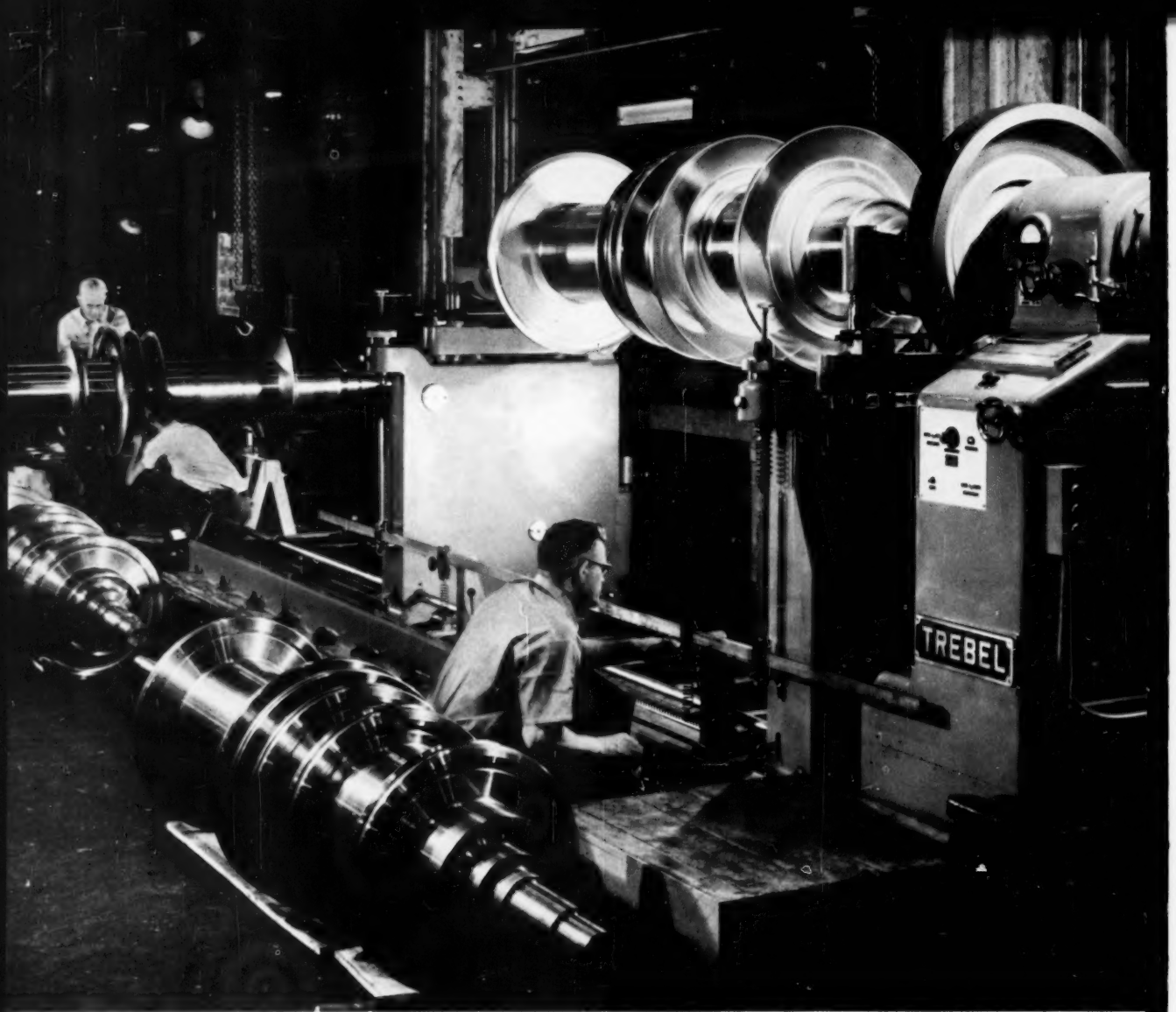
ANTI-OIL-WHIP BEARINGS are standard on Worthington high-speed turbines. A dam in the upper half of the bearing builds up a pressure pad of oil during operation. The pressure creates a downward force on the journal holding it firm in the bearing, thus keeping vibration to a minimum. Anti-oil-whip design increases life, cuts maintenance expense on bearings.

Reliability Fact #5

SENSITIVE SPEED GOVERNING SYSTEM with integral air motor combines extremely close regulation with a broad range of speed adjustment. Governor takes air impulses from an outside controller to vary speed of turbine in accordance with controller's impulse. Sensitive governor is capable of maintaining the output from the compressor substantially constant. Regardless of changes in load or steam conditions, the turbine is always under control of the speed governor, governing at any speed for which the air motor is set.

Reliability Fact #6

MULTI-VALVE AUTOMATIC NOZZLE CONTROL assures most economical operation of the turbine at all loads. Each valve automatically controls the admission of steam to a separate group of nozzles, and is operated by an independent cam mounted on a camshaft. The cams are shaped to give any desired rate of opening. The entire mechanism is mechanical, positive, and far superior to other lower-cost designs.



Balancing rotor for a 6,000 hp Worthington high-speed turbine.

THE MEANING OF LEADERSHIP

Long, trouble-free life of Worthington high-speed turbines stems from two primary sources. One: the multiple achievements of Worthington engineers. Two: the wide variety of tests to which machines are subjected before shipment to customer. Worthington, for example, is the only manufacturer that load-tests all multi-stage turbines. In this process, the turbine is coupled to a water brake so that its precise behavior under actual performance conditions can be predicted. Only when the turbine has passed this — and many other exacting tests — is it approved for shipment. This infinite attention to detail, this painstaking insistence upon perfection, explains why Worthington is today the nation's undisputed leader in high-speed turbine installations. 48-2

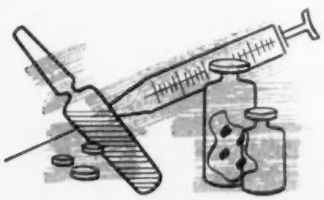
WORTHINGTON

WORTHINGTON CORPORATION, HARRISON, NEW JERSEY

How Can CO_2 Help You?

"CO_2 applications are unlimited"... a broad statement, but literally true. New ways in which this most versatile of all gases is improving products, cutting costs and saving time and labor are being developed almost daily. Some of the applications discussed here will be of direct, primary interest to you. Other uses, while perhaps not in your immediate specialty, may well be *adaptable* to your field. Check the box by each application on which you'd like detailed, technical data and mail this coupon.

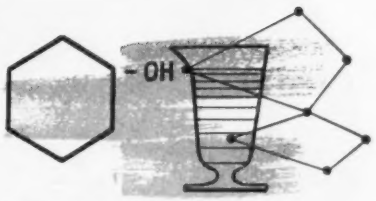
Your inquiry will receive prompt, professional attention from the chemical applications staff of the world's largest producer of CO_2.



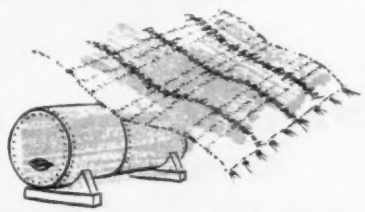
☐ ▶ **Economical, Efficient "Freeze-Drying"**—Freeze-drying is used to dehydrate heat sensitive substances at low temperatures. In the processing of blood plasma and the manufacture of penicillin, streptomycin and other pharmaceuticals, dry ice or liquid CO_2 is used to freeze the item being dried. Also, during the drying stage, dry ice is used to condense the moisture as it is sublimed under vacuum. Capable of quickly attaining and maintaining the extreme low temperatures required, CO_2 has the added advantage of requiring only a small capital outlay.

☐ ▶ **Precipitation of Carbonates**—Carbon dioxide in its gaseous form is used to precipitate carbonates from water solutions. Ammonium bicarbonate and lead carbonate are examples. Bakeries and plastics manufacturers are among the many users of ammonium bicarbonate.

☐ ▶ **Simplifies Pulverizing of Materials With Low Melting Point**—Many substances tend to melt or smear because of the heat generated in a milling process. DDT and vegetable fat flakes which are waxy and Teflon resin which is very tough and elastic are examples. In the low temperature pulverizing process the ingredient is mixed with crushed dry ice or low pressure carbon dioxide liquid is injected directly into the ingredient. These methods effectively inhibit the melting or smearing, prevents plugging and reduces horse power requirements. Gaseous carbon dioxide is also used to form an atmospheric "blanket" to effectively prevent fire during the grinding of flammable materials. An example of this application is the grinding of phosphorus pentasulphide and flammable resin materials.



☐ ▶ **Fireproof "Blanket" For Stored Phenol**—Phenol is a toxic, corrosive, flammable compound and is stored in an inert atmosphere under slight pressure to reduce vaporization, prevent oxidation and at the same time provide a non-flammable atmosphere. Carbon dioxide is also used as a pressure medium in transferring liquid phenol.



☐ ▶ **Effective Inerting Agent**—There are many times when an inert atmosphere is needed to prevent fire or explosion. Before welding a tank that has been used for the storage of flammable liquid, CO_2 is used to inert the atmosphere in the tank so that welding can be done with no danger of explosion. CO_2, acting as an effective atmospheric "blanket," also prevents oxidation and "skinning" of paints and oils.

SEND IN THIS COUPON FOR COMPLETE INFORMATION

Check off the applications which interest you, fill in name and address, and mail the coupon to Liquid Carbonic for prompt information. You'll also receive a free copy of our Booklet, "Applications Unlimited", which covers dozens of other important uses of CO_2.

World's Largest Producer of CO_2

LIQUID CARBONIC

DIVISION OF GENERAL DYNAMICS CORPORATION

☐ Economical, Efficient "Freeze-Drying"
☐ Precipitation of Carbonates
☐ Simplifies Pulverizing of Materials With Low Melting Point
☐ Fireproof "Blanket" For Stored Phenol
☐ Effective Inerting Agent
☐ Other _____

_____

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Title _____ Company _____

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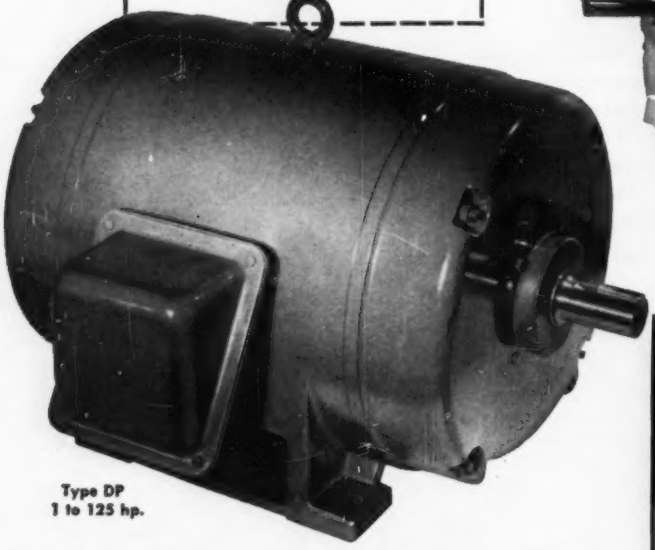
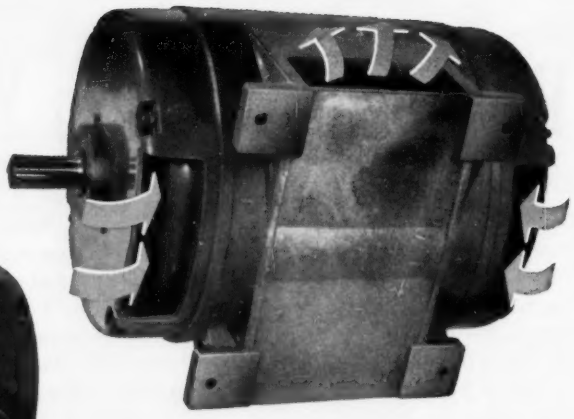
WAGNER
POLYPHASE
MOTORS



Type DP
1 to 125 hp.



DOUBLY PROTECTED — Wagner DP Motors offer the *double protection* of completely dripproof enclosures and rugged cast iron frames that can take rough handling and resist corrosion.

These open type motors give DOUBLE PROTECTION... can be used in many places that formerly required splashproof motors

Wagner Type DP Motors offer the *double protection* of rugged corrosion-resistant cast iron frames and dripproof enclosures so well designed that the DP Motor can handle many applications that formerly required splashproof motors.

These Wagner Motors are built in the new NEMA ratings that pack more power into less space, are lighter in weight and are easier to maintain—only occasional lubrication is required.

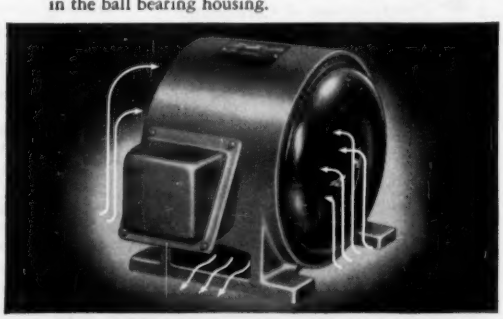
SLEEVE BEARING MODELS AVAILABLE

The entire line of ratings through 125 hp. is available with steel-backed, babbitt lined sleeve bearings that have high carrying capacity and provide quieter operation.

Let a Wagner Sales Engineer show you how these motors can be applied to your needs. Call the nearest branch office or write for Wagner Bulletin MU-223.

1 to 125 HP—1750 RPM—40°C NEMA FRAMES 182 through 445U

CAN BE RELUBRICATED — These motors can be re-greased when desired for longer bearing life. Fresh grease can be added—old grease removed—through openings provided in the ball bearing housing.

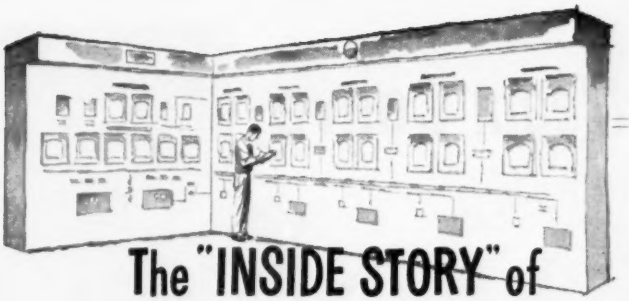


COOL RUNNING — Specially designed baffles direct cooling air through the motor to protect the stator windings. Blowers, cast as part of the rotor, move large volumes of air without noise or vibration.

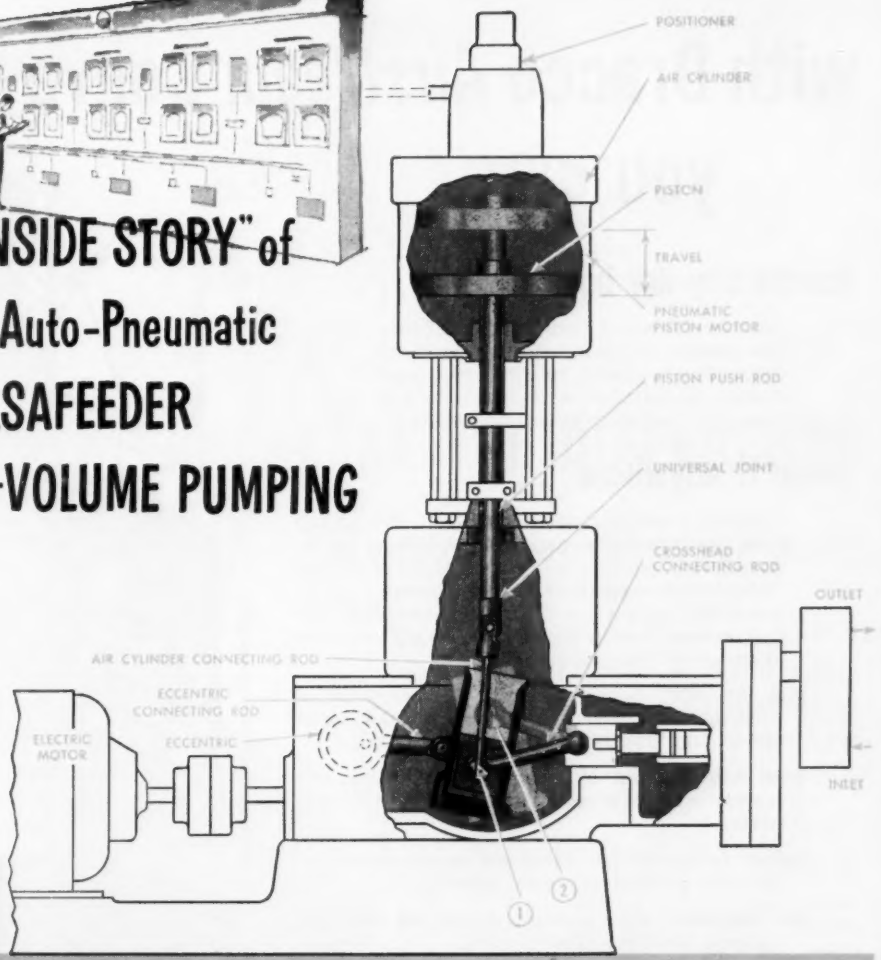
Wagner Electric Corporation
6407 Plymouth Ave., St. Louis 14, Mo., U.S.A.

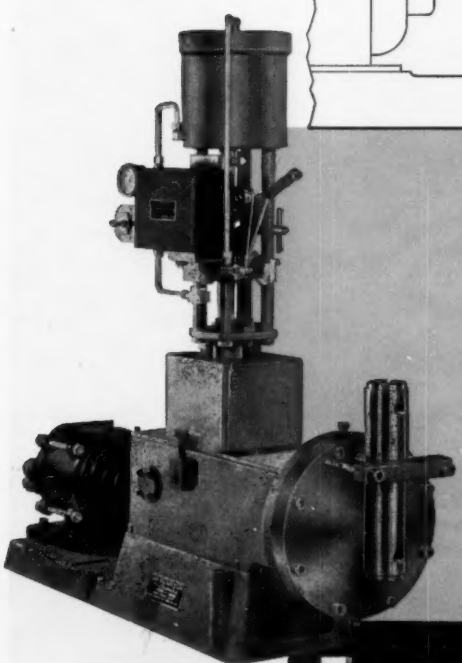
WH58-B

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES



The "INSIDE STORY" of Auto-Pneumatic PULSAFEEDER CONTROLLED-VOLUME PUMPING





In many industrial processes, liquids must be metered in relation to some changing process condition. It can be a change in flow or pH, temperature or pressure. Instruments can sense such a change and transmit an air signal descriptive of that change. The auto-pneumatic control mounted on the Pulsafeeder pump receives and interprets this signal and automatically adjusts pump to meet the process variable. This is accomplished by a positioning device on the auto-pneumatic control that loads or unloads the air cylinder, accurately moving the air piston to position the connecting rod (1) in relation to the axis (2). This determines the stroke length of the pump—a longer stroke increases pump output; a shorter stroke reduces output. Instrument air pressure over a range of 3-15 psig. controls Pulsafeeder output from 0-100% of capacity. Ratio adjustment is available in all models.

WRITE FOR BULLETIN 440 *with typical applications, flow charts, description and specifications of both* MANUALLY CONTROLLED *and* AUTO-PNEUMATIC *models of various capacities and constructions. Inquiry Data Sheet included from which we can make specific engineering recommendation for your processing requirement. Write Lapp Insulator Co., Inc., Process Equipment Div., 3603 Poplar St., Le Roy, N. Y.*

Lapp

with Dracco *Airstream* Conveyors you can:

handle any dry bulk material . . .

Airstream Conveyors handle hundreds of materials from fine powders to 2-inch lumps: grains, cereals, chemicals, fertilizers, plastics, pulverized rock products. Self-cleaning systems can move two or more materials in quick succession to proper destinations without intermixing.

move it anywhere . . .

Airstream Conveyors move materials **to, through** and **from** production processes. Walls and floors are no obstacles . . . pipelines can be installed out of the way without costly supports and are easily adapted to any new or existing plant layout. Airstream versatility permits bulk material flow in any direction, at any angle and at any desired handling rate.

. . . **with less labor** through elimination of costly manual handling. Most systems require only part-time supervision of one man.

. . . **lower material cost** by permitting bulk-buying. No material is wasted or spoiled from moisture or contamination.

. . . **greater safety** with no hazardous moving mechanical parts and no exposure to toxic materials.

. . . **and cleanliness** since Airstream systems are completely enclosed, dust-free and self-cleaning.

For the profitable answer to your bulk handling problem, call in a Dracco engineer soon. Write or call:

DRACCO DIVISION OF FULLER CO.

4040 East 116th Street • Cleveland 5, Ohio

New 32-page brochure presents detailed information on how Dracco Airstream Conveyors have solved bulk materials handling problems. Write for Bulletin 530.

DRACCO *airstream* conveyors
dust control equipment

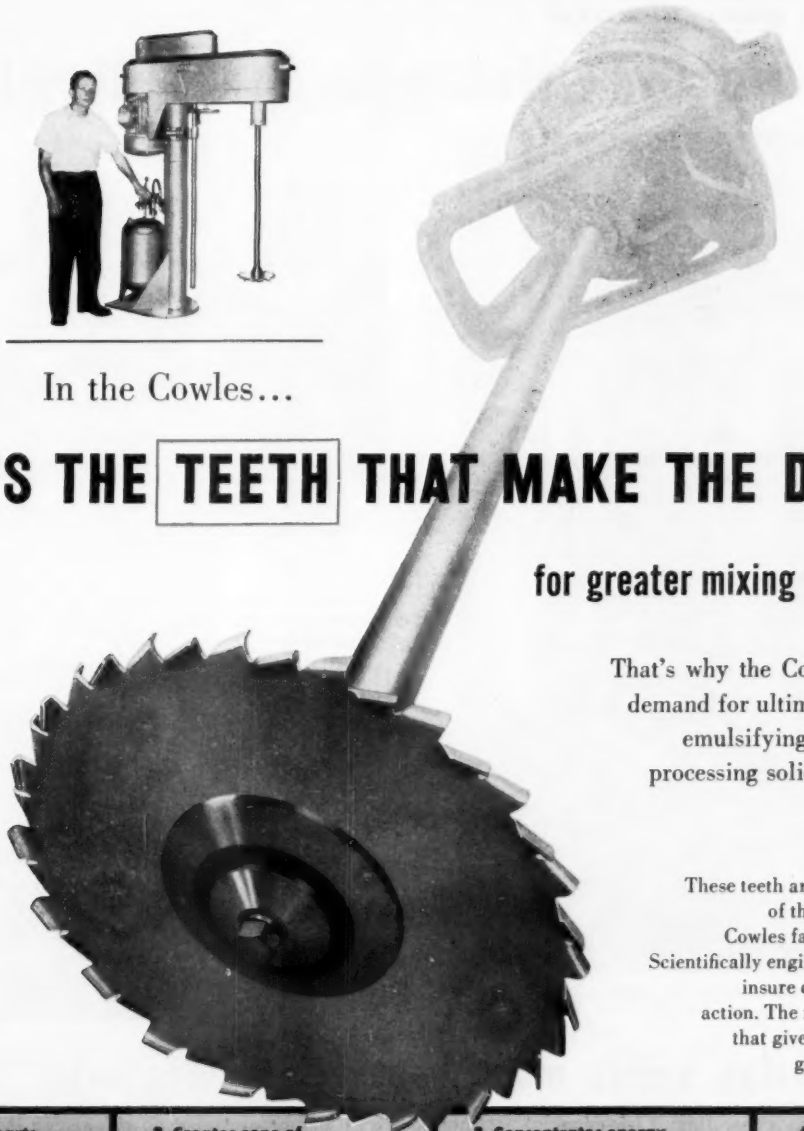
In the Cowles...

IT'S THE TEETH THAT MAKE THE DIFFERENCE

for greater mixing volume and quality

That's why the Cowles Dissolver is most in demand for ultimate dispersion, dissolving, emulsifying and deagglomerating—in processing solid-liquid, liquid-liquid and gas-liquid materials.

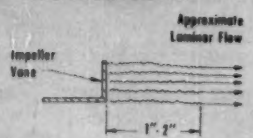
These teeth are an exclusive, patented feature of the Cowles Impeller. They set the Cowles far ahead of conventional mixers. Scientifically engineered power and drive systems insure complete control of the impeller action. The result is shown here in the steps that give you "MULTI-PHASE" mixing for greater volume and finer quality.



1. Imparts high velocity to material.

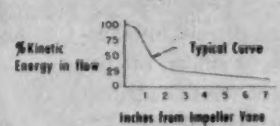
3000-6000 F.P.M. in production models

2. Creates zone of intense turbulence.



Two actions cause rapid hydraulic attrition in this zone:
Shear—Rubbing of particles on each other and scrubbing of liquid phase on surfaces of solid phase.
Impact—Particle collisions due to directional differentials.

3. Concentrates energy close to impeller.



The turbulent zone is a zone of intense energy dissipation. Nearly 75% of the kinetic energy is used for hydraulic attrition in a distance of 1"-2" from the impeller vanes.

4. Causes laminar flow for "Total Motion"

Beyond the turbulent zone the movement becomes laminar. This flow divides at the vessel wall assuring complete circulation of the entire batch. Turbulence does not interrupt flow pattern.

5805

MOREHOUSE COWLES

Representatives in principal cities
Convenient lease and time payment plans

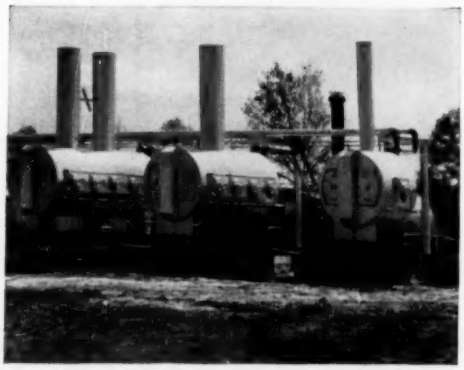
The Cowles is adaptable to your materials, processes and present equipment. Cowles engineers will be happy to work with you in solving your processing problems economically. Their solutions are based on the industry's most advanced research. Let us prove it in your plant at our risk! Write today for complete information and catalog.

MOREHOUSE-COWLES 1150 San Fernando Rd., Los Angeles 65, Calif.

our research is your reward

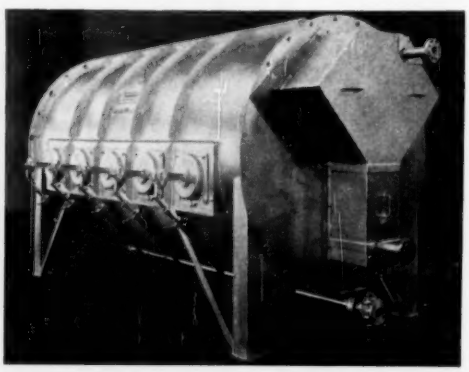
Small Gradiation® Heaters do a Big Job

Gradiation barrel heater superheats steam in two precisely-controlled stages of continuous coking process at Tidewater Oil Co.'s new Delaware refinery.



Above: Three low-capacity Gradiation heaters . . . ½-million, 1-million, 2-million Btu/hr . . . in reboiler service at a Louisiana refinery.

Below: 2-million Btu/hr Gradiation unit provides uniform heating and good thermal efficiency for asphalt service.



. . . because Selas builds more heat into fewer cubic feet!

It's important for you to know this: Low-capacity Gradiation Heaters deliver heat uniformity at lowest possible structural cost!

In the chemical, petrochemical and petroleum industries . . . where heat capacities under 10 million Btu per hour are desired . . . the advantages of Selas Gradiation may now be enjoyed *at low first cost.*

Selas Gradiation uses a multiplicity of Duradiant® burners which may be placed only 2 feet from the tubes. This makes possible smaller, more compact heaters, with consequent savings in structural costs.

On the other hand, conventional heaters use relatively high capacity flame-type burners which require greater heater volume to avoid flame impingement on the tubes.

In addition to low first cost resulting from structural savings, you get these advantages with Selas Gradiation:

- Duradiant burners permit *instant response to controller demand*
- Uniformity of heat application with no flame impingement and complete combustion with no excess air *combine to eliminate "tube metal" degradation*

For low-capacity heating with low first cost you should choose Selas Gradiation.

For complete information write for Bulletin 149 "Gradiation Heating for Petroleum and Chemical Processing."

Gradiation and Duradiant are registered trade names of Selas Corporation of America.

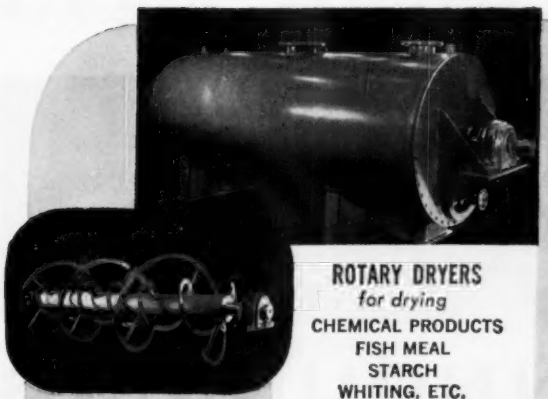
SELAS
CORPORATION OF AMERICA
DRESHER, PENNSYLVANIA

Heat and Fluid Processing Engineers

DEVELOPMENT • DESIGN • CONSTRUCTION

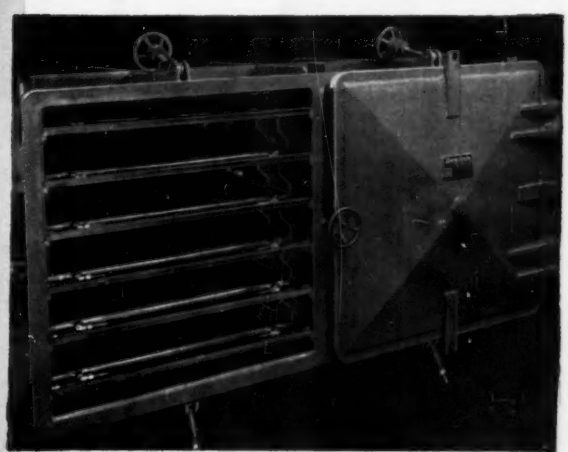
Devine Vacuum Dryers

CHAMBER • ROTARY • CONICAL • DRUM

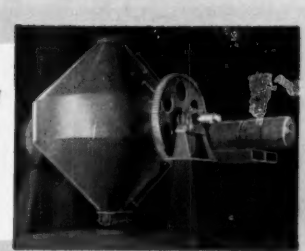


ROTARY DRYERS
for drying
CHEMICAL PRODUCTS
FISH MEAL
STARCH
WHITING, ETC.

Devine builds all standard and many special types of dryers. Choose the best type for drying your products by using DEVINE'S TESTING LABORATORY

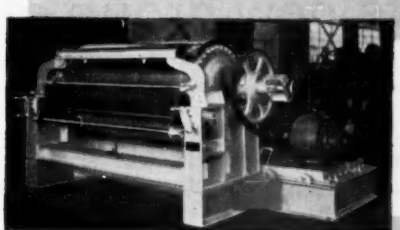


CONICAL DRYERS
for drying and blending
CHEMICAL PRODUCTS
PHARMACEUTICALS
DYES
PLASTICS
and other materials



CHAMBER DRYERS *for drying materials such as*

SHELLAC	ASBESTOS BOARD STOCK
CAPILLARY TUBES	ANALINE DYES
TITANIUM SPONGE	PLASTIC STOCK
PHARMACEUTICALS	FOOD PRODUCTS
BATTERY PLATES	ELECTRONIC PARTS



DRUM DRYERS
for drying
DEHYDRATED FOODS
BEVERAGES
CHEMICAL PRODUCTS
and many others

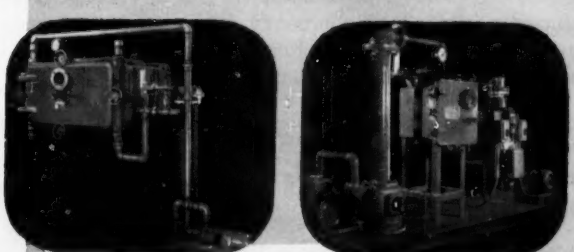
In all DEVINE vacuum drying, materials may be dried to extremely low moisture content (of the order of .02% moisture). Dependability is assured by more than 50 years of Devine experience.

Sturdy construction, automatic control where applicable, and many patented, time and labor saving devices are features of DEVINE Dryers.

Write for Details or Phone MUseum 2-5740

J. P. DEVINE MFG. CO.

49th Street & A.V.R.R. Pittsburgh 1, Pa.

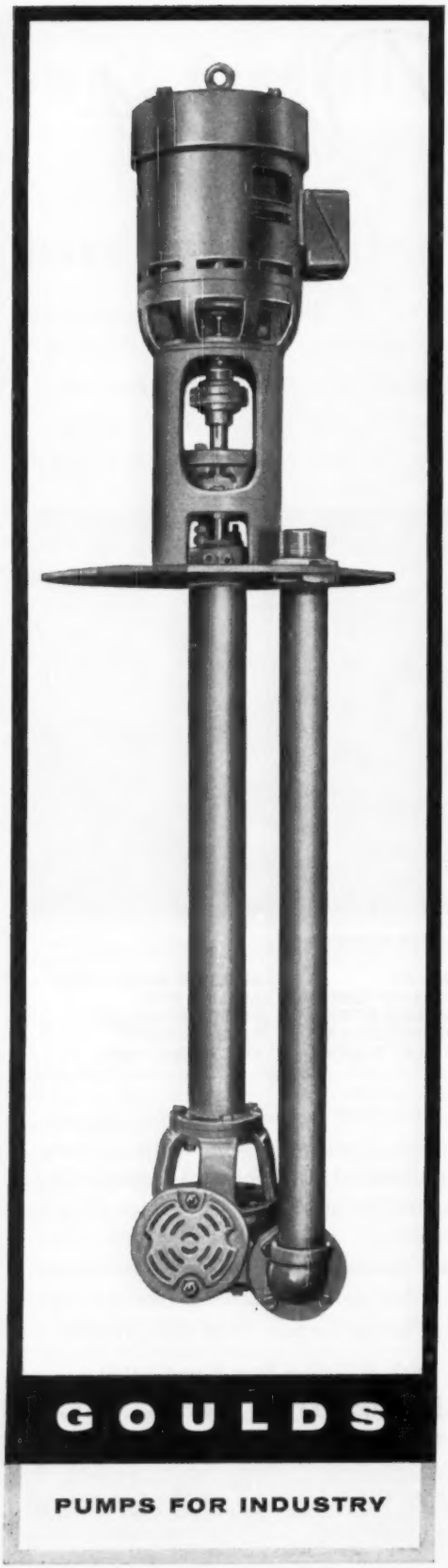


DEVINE COMPLETE PACKAGED DRYING SYSTEMS
include dust collector, condenser for vapors, vacuum pump, and hot water heating system where used.

EXPORT OFFICE:
50 Church St., New York 7, N. Y.
Cable Address: "Bresites"

NEW YORK OFFICE:
500 Fifth Ave., New York 36, N. Y
Phone: WIsconsin 7-7769

C-6



GOULDS

PUMPS FOR INDUSTRY

new way to pump corrosives

ANNOUNCING

a complete new group of vertical process pumps

How often would a vertical pump be just the ticket for transfer or other service . . . *except for the fact that you're handling a corrosive liquid?*

Now you can choose from a complete line of vertical process pumps especially built for heavy-duty service, pumping corrosive liquids. Goulds now offers a wide range of vertical pumps in highly corrosive-resistant materials.

Special constructions available. Standard construction of Goulds new vertical process pumps is 316 stainless steel . . . and other materials to meet your requirements are available on application.

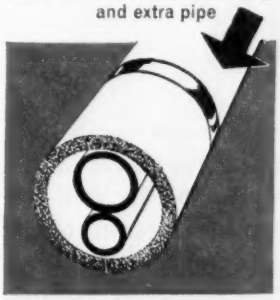
Free bulletin. To discover all the outstanding features of this new line of heavy-duty vertical pumps, contact your nearest Goulds representative and ask for a free copy of Bulletin No. 727-1. Or write to Dept. CE-98, Goulds Pumps, Inc., Seneca Falls, N. Y.

Now! One-pipe steam-traced systems with new Reynolds Aluminum Duplex Pipe with steam line built-in.

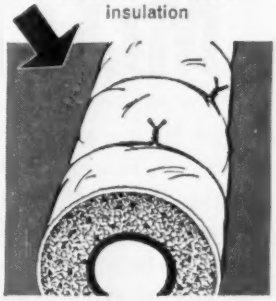
THIS ELIMINATES

THESE UNNECESSARY COSTS:

...the cost of steam jacketing and extra pipe



...the cost of excessive insulation



Now a complete steam-traced system can be installed in one pipe: Reynolds new Aluminum Duplex Pipe.

This tough, lightweight pipe has a *built-in* steam line . . . it eliminates the need for steam jacketing . . . it eliminates outside steam-trace lines . . . it permits use of standard insulation . . . it's a complete steam-trace system in one pipe.

Installation is fast and simple, too, with Reynolds Duplex Pipe. It's lightweight and easy to handle, join and weld, and can be formed readily with ordinary hydraulic pipe bending equipment.

The new Reynolds Duplex Pipe can improve heating efficiency, and reduce the need for insulation. Aluminum has high thermal conductivity, low emissivity. This means better heat transfer within the Duplex Pipe, less heat lost, less insulation needed.

And, like the Reynolds Aluminum Process Pipe that is handling the roughest jobs in the chemical processing and petroleum industry, the new Duplex Pipe stands up against corrosion.

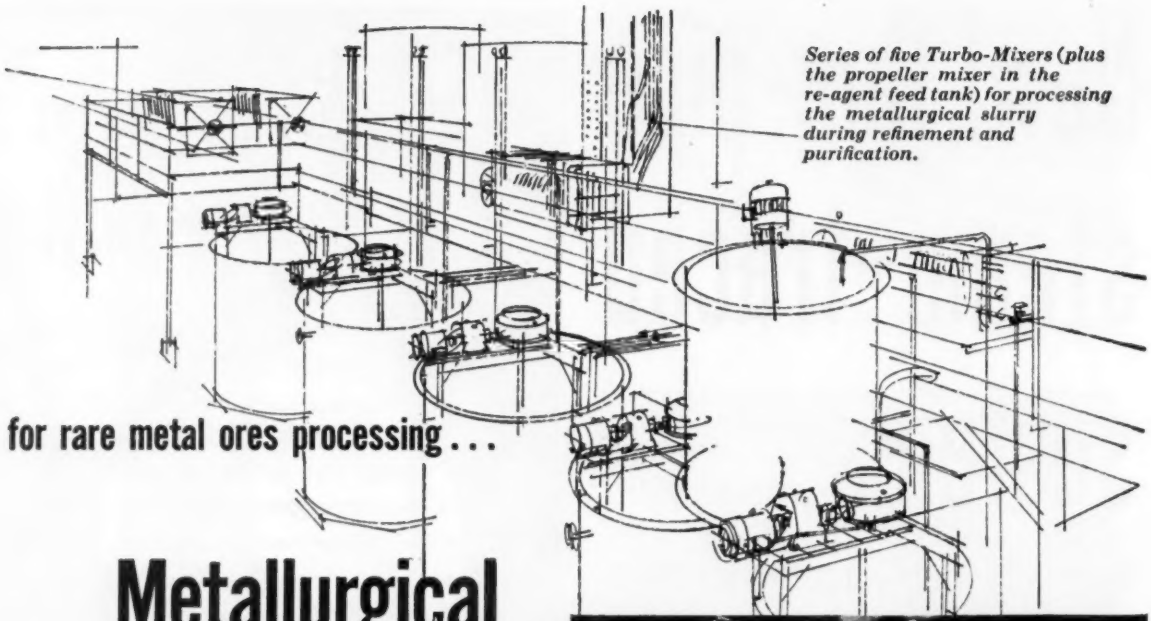
Reynolds Duplex Pipe is available in four sizes —1½", 2", 3" and 4"—and in alloys 3003-F, and 6063-T5.

The Finest Products Made with Aluminum are made with REYNOLDS ALUMINUM

Get full information on Reynolds Duplex Pipe

FREE BROCHURE

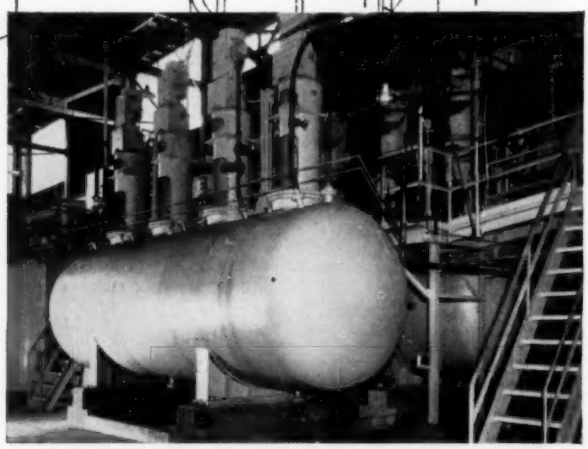
Write today for a free brochure on Reynolds Aluminum Duplex Pipe, for details on joining, sizes, alloys and pressure ratings. *Reynolds Metals Company, P.O. Box 1800- CJ, Louisville 1, Kentucky; International Division, 19 East 47th Street, New York 17, New York.*



Series of five Turbo-Mixers (plus the propeller mixer in the re-agent feed tank) for processing the metallurgical slurry during refinement and purification.

for rare metal ores processing . . .

Metallurgical Resources chooses TURBO-MIXERS



Four-compartment autoclaves for pressure leaching of ore. Each mixer consists of a mixing and aeration assembly to accomplish the contacting of the liquid-solid-gaseous phase system.

There is no easy way to extract rare metals from their ores. Processing plants, such as that of Metallurgical Resources, Inc. of Newburgh, New York, call for skillful design and dependable processing equipment. To help put this new plant "on stream", Turbo-Mixer custom made all of the equipment required.

Turbo's 45 years of experience in design . . . Turbo's record of dependability . . . and Turbo's single-source responsibility make the difference. If you are in the process of selecting or specifying mixing equipment, call on Turbo. You'll find . . . *it pays to plan with General American.*

FOR DETAILED INFORMATION AND USEFUL DESIGN DATA, SEND FOR THE FOLLOWING BULLETINS:

Please send me the following Turbo-Mixer Bulletin (s):

General Turbo-Mixer Bulletin_____

RDC Extraction Column Bulletin_____

Side Entering Propeller Mixer Bulletin_____

Absorption & Oxidation Bulletins_____

TURBO-MIXER DIVISION
GENERAL AMERICAN TRANSPORTATION CORPORATION

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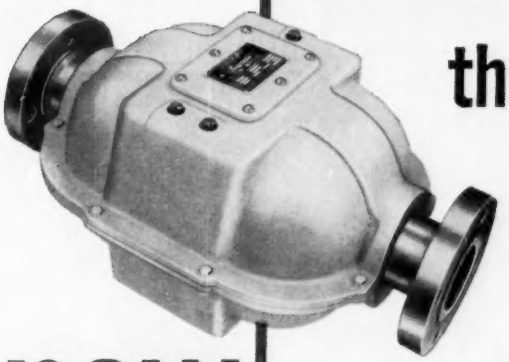


the meter with NO flow restrictions

now handling all these difficult liquids

Foxboro's first Magnetic Flow Meter went "on stream" in 1954. Today, this new-type meter has gained industry-wide application for precise, continuous measurement of difficult process liquids.

The Magnetic Flow Meter is installed as simply as a length of pipe. No seals, purges, meter runs, or straightening vanes are required. It connects by standard electric cable to remote Dynalog Electronic Recorder. Over-all accuracy of the system is ±1%. And the meter even measures reversing flows.

With easy-to-measure liquids, or with tough ones like those listed below, the performance-proved Foxboro Magnetic Flow Meter provides flow measurement with no line restrictions. For complete details, write today for Bulletin 20-14B. **The Foxboro Company, 109 Norfolk St., Foxboro, Mass.**

CHEMICALS

ammonium nitrate solution
phosphate slurry
rayon viscose
magnesium carbonate slurry
phosphoric acid slurry
detergent concentrate
rosin size
starch solution
rubber copolymer
liquid latex
soda ash
sulphuric acid
70% sodium hydroxide
soap flow
styrol
magnesium hydrate

FOOD
beer
grape juice
apple juice
pineapple juice
tomato juice
milk
starch slurry
sugar syrup
coffee slurry
molasses

METALS AND MINING
pickling acid
sand slurry
ferrous chloride
limestone shale slurry
bauxite slurry
gilsonite slurry
aluminate liquor
uranium ore slurry
thickener mud
cement slurry
flue dust slurry
acid wastes

OIL INDUSTRIES
drilling mud
phosphoric acid
ethenol extract
scrubber recycle water
urea solution
nitrate solution
spent acid
sodium silicate & water
sodium chloride brine
tar-sand slurry

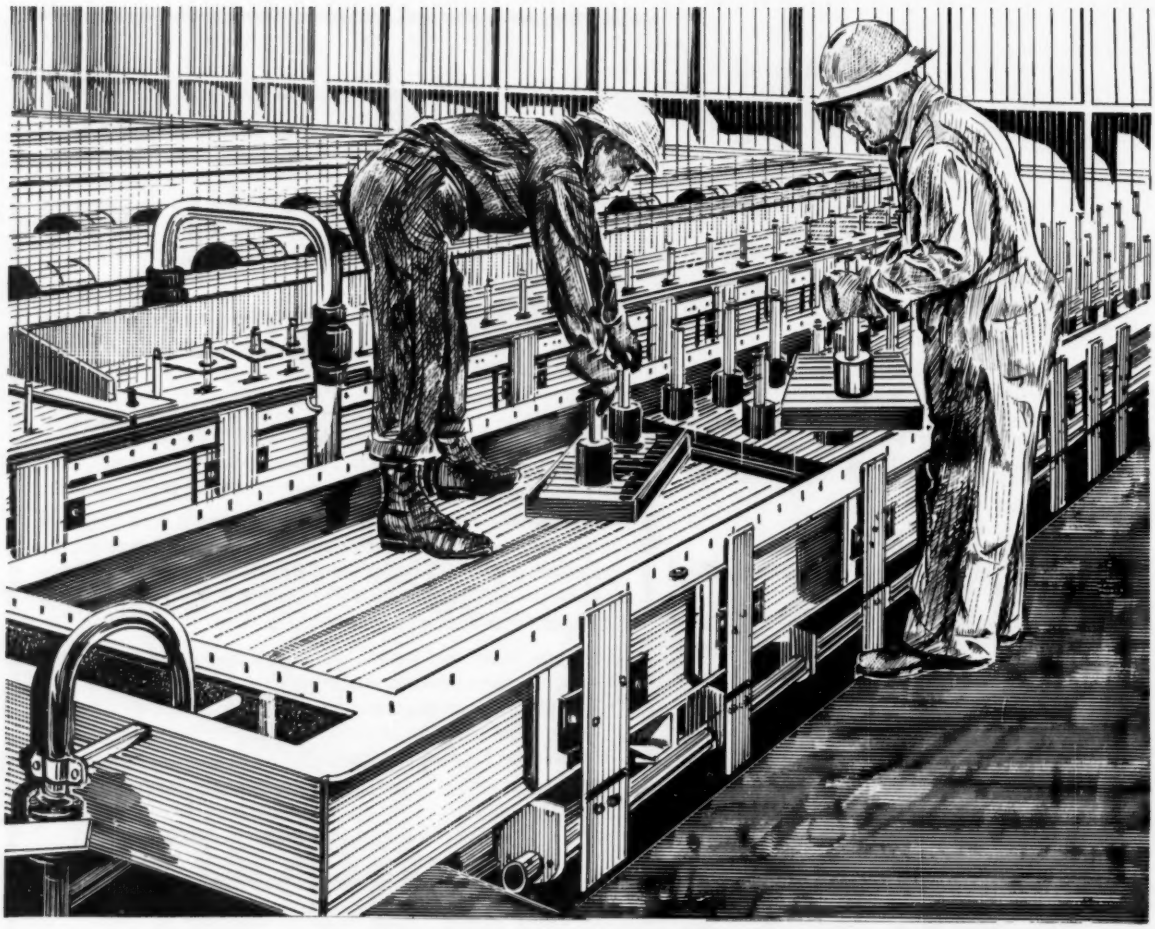
PULP & PAPER
all types of pulp stock
cooking liquors
spent liquors
bleaching chemicals
lime mud sluries
sizes
alum
dyes

WATER & SEWAGE
activated sludge
fresh water
raw sewage
digested sludge
primary sludge
return activated sludge

METER SIZES RANGE FROM 3/16 INCH TO OVER 6 FEET PIPE DIAMETER

FOXBORO
REG. U.S. PAT. OFF.

MAGNETIC FLOW METERS



Preview of production

Top efficiency of high capacity mercury cells depends upon the special ablities of the men who build and maintain them.

Another vital factor in high productivity is the efficiency of GLC Anodes which are "custom made" for individual cell requirements.

FREE – *This illustration of cell maintenance has been handsomely reproduced with no advertising text. We will be pleased to send you one of these reproductions with our compliments. Simply write to Dept. J-10.*

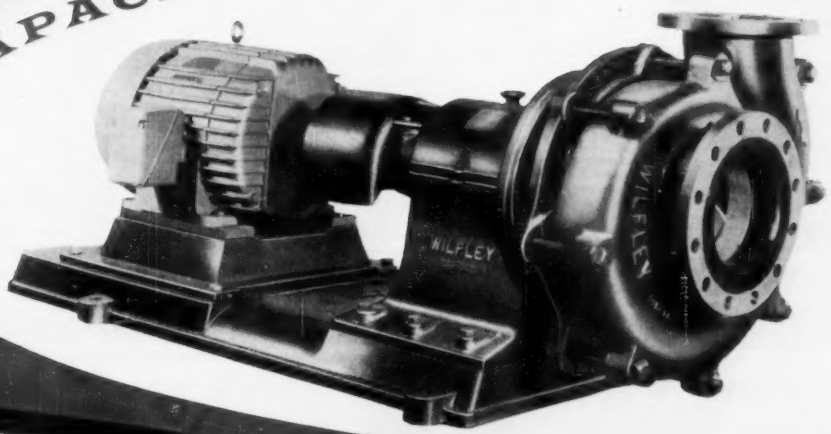
ELECTRODE GLC® DIVISION

GREAT LAKES CARBON CORPORATION

18 EAST 48TH STREET, NEW YORK 17, N.Y. OFFICES IN PRINCIPAL CITIES

NEW! WILFLEY
8 INCH ACID PUMP

CAPACITIES TO 3000 GPM!



SUPERIOR PERFORMANCE!

Now Wilfley's famous line of Model "AF" Acid Pumps includes 1″ to 8″ discharge sizes with 10 to 3000 GPM capacities, and heads up to 200′! This new 8″ pump incorporates the same dependable, economical features that characterize all Wilfley Acid Pumps . . . **continuous, trouble-free operation, lower maintenance costs, longer pump life, higher output.**

Wilfley Acid Pumps are available with pumping parts of the machinable alloys as well as plastic to meet all requirements.

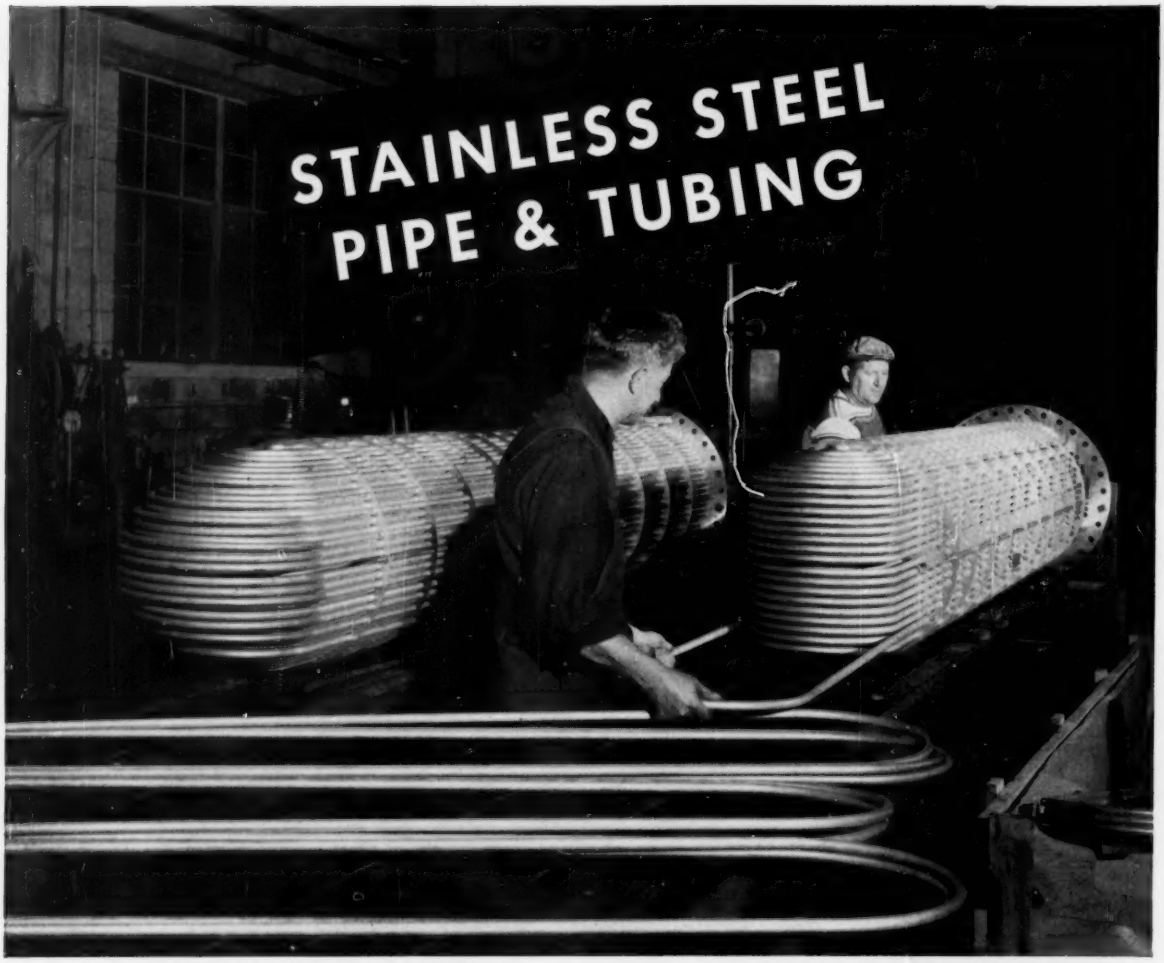
INDIVIDUAL ENGINEERING ON EVERY APPLICATION

Write, wire or phone for complete information.

Wilfley Sand Pumps
Companions in Economical Operation
Wilfley Acid Pumps

A. R. WILFLEY and SONS, INC.

DENVER, COLORADO, U. S. A. • P. O. BOX 2330 • NEW YORK OFFICE: 122 EAST 42ND STREET, NEW YORK CITY 17



ODDS AGAINST LEAKERS · · · 3400 TO 1

The percentage is all in your favor when you use Damascus tubing. Customer claims entered for settlement over a 5-year period amounted to only 3/100 of 1% of all tubing shipped. A remarkable record—one that can save you time and money. On new equipment or when you are re-tubing, always specify Damascus. Available in stainless for normal corrosive service . . . and in reactive metals and super-alloys for special applications.

U-TUBES OR SPECIAL BENDING — Damascus is also able to supply U-tubes fabricated to your specifications, as well as precision coiling and custom bending. For additional information, write or call.

COMPLETE INFORMATION on RARE and REACTIVE METALS PIPE and TUBING

New 44-page handbook contains data on applications, heat treatment, corrosion resistance, chemical and physical analysis, mechanical properties of Zirconium, Zircaloy 2, Zircaloy 3; Titanium, grades 40, 55, and 70; Precipitation Hardening Steels, A-286, 17-7-PH, 15-7-MO; Hastelloys A, B, C, F, and X.

AMERICAN STEEL WAREHOUSE ASS'N.

DAMASCUS TUBE COMPANY

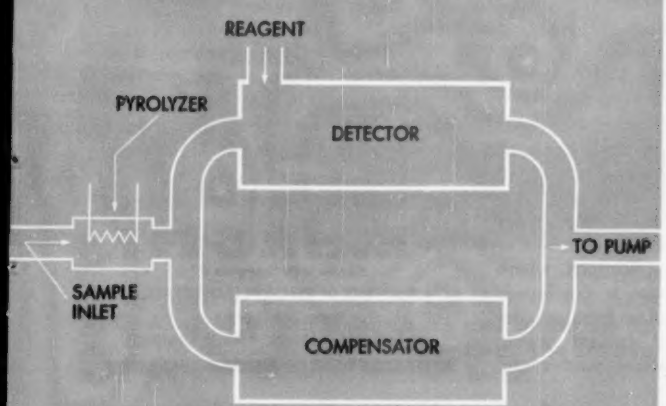
STAINLESS STEEL TUBING AND PIPE

GREENVILLE, PENNSYLVANIA

FORMED STEEL TUBE INSTITUTE

MSA's new ionization detection system displays high sensitivity for acid gases such as HCl, HF, SO_2, HCN, N_2O_4; alkaline gases such as ammonia, hydrazene, amines; halogenated chlorinated hydrocarbons such as carbon tetrachloride, trichloroethylene, ethylene chloride, ethylene bromide; and some insecticides.

Schematic flow diagram shows compensated detection system using two similar ion chambers. Sample gas is drawn in through single inlet, then equally divided between two chambers. One of these, the detector chamber is supplied with constant flow of reagent (when required). The other (compensator) is not supplied with reagent.



New M-S-A® Ionization Chamber detects airborne and process contaminants in the range of parts per billion

Application: air pollution studies and process monitoring

Problem: continuous, more sensitive measurement of toxic gases or vapors in traces as small as a few parts per billion

Solution: MSA's new ionization method of gas detection

MSA has been asking questions and coming up with the right answers in the field of gas analysis for over 30 years. Latest result of this probing inventiveness is a simplified ionization method of gas detection.

Principle of the M-S-A Ionization Chamber is unique, indeed. It measures electrically, in a specially designed ionization chamber, any decrease in the conductivity of ionized gas samples caused by removal of ions by the contaminant being measured. A radioactive material in the chamber produces continuous ionization.

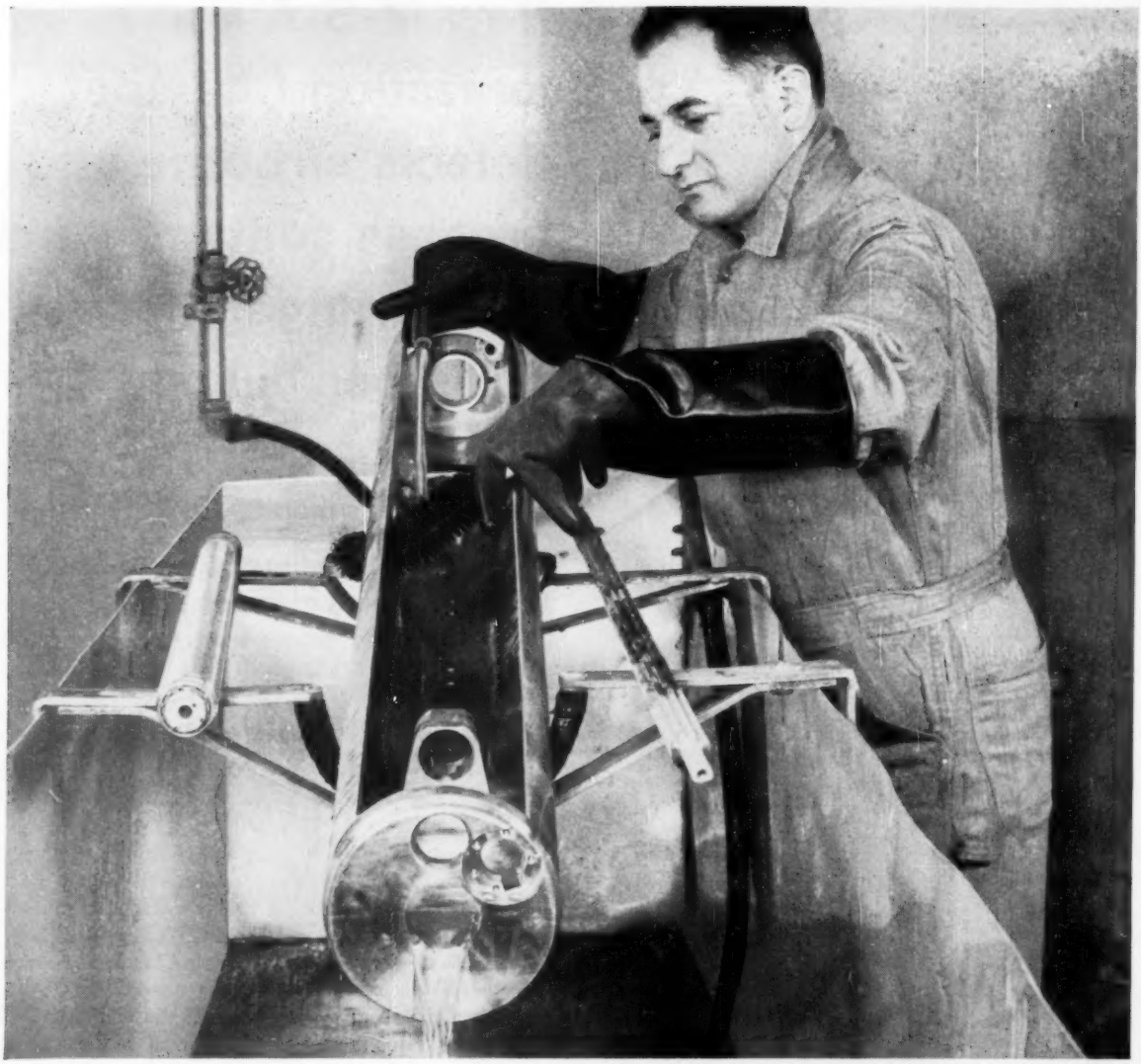
Gas to be detected enters the chamber with a sensitizing reagent. Said gas may react chemically with the reagent to form sub-micron particles. Or, if the gas is electronegative, in a non-electronegative process gas, it may be detected without the need of additional sensitizing means.

Various sensitizing techniques assure a wide range of selectivity. Already, this new instrument can detect a large number of gases. The number increases as new sensitizing techniques are developed.

An MSA Instrument Specialist would be pleased to discuss in detail the materials which this device detects and measures so sensitively. Ask us for this man's name. And write us for descriptive literature.

INSTRUMENT DIVISION

Mine Safety Appliances Company
Pittsburgh 8, Pennsylvania



A control rod drive housing being rinsed at Fairchild Camera and Instrument Corp. Radiological Decontamination Laboratory, Syosset, L. I., N. Y.

Ion exchange helps save "hot" reactor mechanisms from the nuclear cemetery

When valves, pumps, heat exchangers and other parts used in or with nuclear reactors became sluggish or clogged, they used to be taken out and buried in the ground because they were radioactive . . and replaced by new parts. This ran into money. A single control rod drive mechanism, for example, costs $30,000.

Now radioactive contamination is actually scrubbed off and rinsed away so that parts can be refurbished, reassembled and re-used . . at a fraction of their replacement cost.

Radioactive rags, brushes and cleaning fluids used for decontaminating are put in special containers and disposed of through licensed agencies.

But the problem of what to do with the contaminated rinse water is easily solved at Fairchild by their Permutit Nuclear Purifier. Each refill of 3 cubic feet of Permutit ion exchanger resin in this unit safely decontaminates thousands of gallons of rinse water!

Other nuclear applications where Permutit ion exchange is employed: concentration of uranium from ore, demineralizing reactor coolant water, treatment of radioactive wastes and purification of heavy water.

Permutit's nuclear experience is at your service. Write to the Permutit Company, Dept. CE-9, 50 West 44th Street, New York 36, or Permutit Company of Canada, Ltd., Toronto 1, Ontario.

PERMUTIT®

rhymes with "compute it"

A DIVISION OF PFAUDLER PERMUTIT INC.

Water Conditioning

Ion Exchange • Industrial Waste Treatment

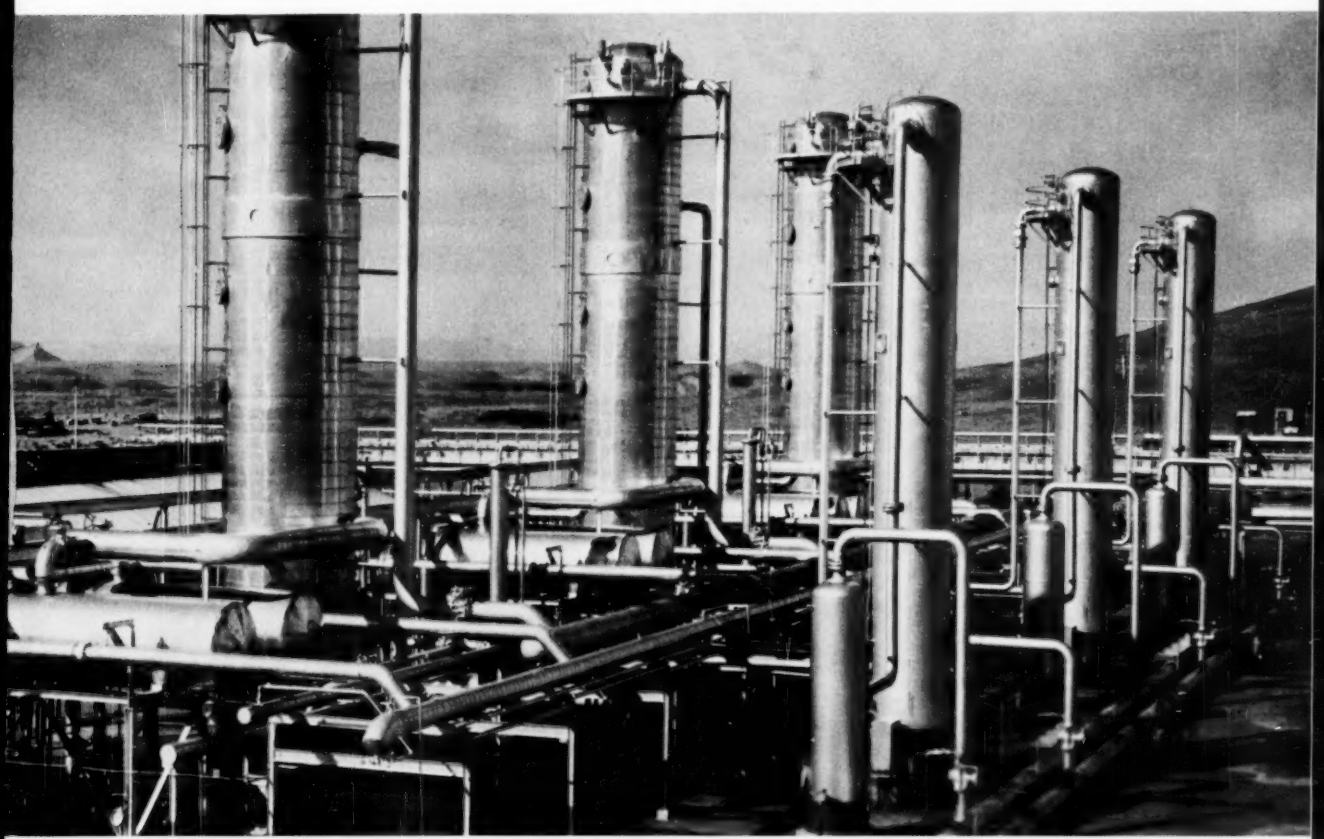
SPECIFICATION:

Process Equipment; Plant Structures; Transfer and Storage Equipment . . . shall be Alcoa Aluminum to resist corrosion

The one best answer to the process industries' problem of skyrocketing plant and equipment costs is to reduce corrosion damage. Fortunately there is a performance-proved way to do just that: specify Alcoa® Aluminum and ensure *corrosion-resistant* process equipment, transfer and storage equipment and plant structures.

No other metal matches the ability of aluminum to resist corrosive attack in so many operating environments. Happily, aluminum is usually the *least costly* metal able to serve satisfactorily in such situations. And aluminum, alone, provides the complete combination of important service benefits listed at the right.

Light Weight • Great Strength in Alloys • Good Workability • High Thermal and Electrical Conductivity • Nontoxicity • Good Reflectivity • Nonmagnetic, Nonsparking Characteristics • Clean, Attractive Appearance • Low Cost



On the following pages, you will find some of the many applications in which Alcoa Aluminum is daily being used to win the fight against corrosion in the process industries. Among them, you are sure to find ways in which *you, too,* can win this important battle.

ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

SPECIFICATION: *Process Equipment; Plant Structures; Transfer*

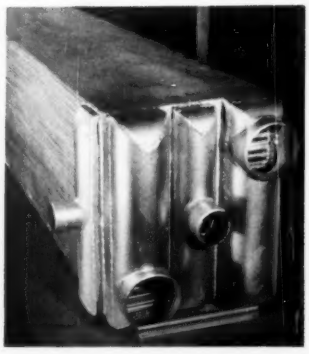
HEAT EXCHANGER TUBES

Low cost aluminum heat exchanger tubes combine initial equipment economies with freedom from chemical attack. Easy to fabricate, they have excellent thermal conductivity and are not subject to embrittlement at low temperatures.

Aluminum tubes have thoroughly demonstrated their ability to give long-lasting, dependable service in severe operating conditions. They have been used extensively in exchangers handling hydrogen peroxide, nitric acid, hydrogen sulfide, naval stores, glycerine, ammonia, hydrocarbons, steam acrylonitrile and many other chemicals. Alclad tubes are recommended for use with natural cooling waters.

Remember, too, that aluminum costs far less . . . ½ the cost of admiralty, less than 1/5 the cost of stainless, and even less than mild steel in common ¾″ and 1″ sizes.

Write for booklet AD186 containing detailed information on heat exchanger tubes of Alcoa Aluminum.



This brazed aluminum assembly, weighing nearly 900 pounds, is typical of exchangers used in air separation plants and other low-temperature exchange processes.

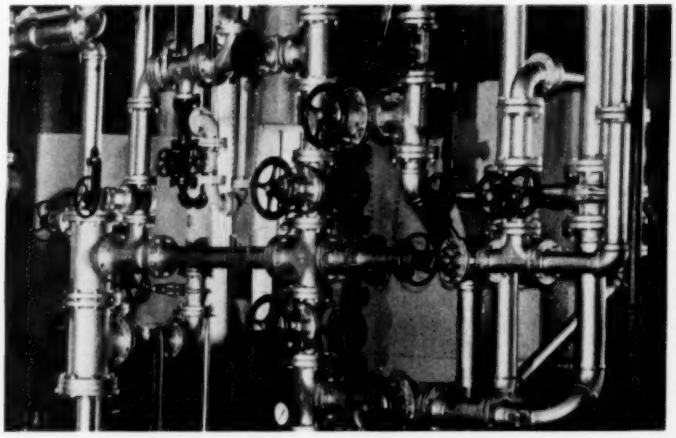
A 105,000 sq ft surface condenser with Alcoa aluminum heat exchanger tubes.

PROCESS PIPING

You get two-fold protection when you specify Alcoa Aluminum Pipe to carry liquids or gases in chemical, petrochemical, petroleum and food plants. It resists attack from the materials it carries as well as from corrosive atmospheres surrounding it. Naturally, the use of aluminum pipe will not introduce unwanted product contamination or discoloration.

Available in all normally produced schedules, Alcoa Aluminum Pipe is easily the lowest priced corrosion-resistant pipe available. For example, Schedule 40 aluminum pipe is ¼ the cost of Schedule 5 stainless and only 1/7 the cost of Schedule 40 stainless.

For more information, Send for booklet AD197, *Aluminum Pipe and Fittings.*

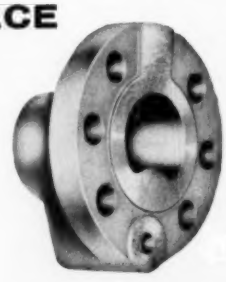


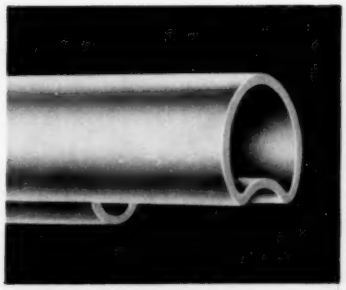
Alcoa aluminum pipe proved ideal to solve corrosion and product contamination problems in this processing plant.

UNITRACE

Only Alcoa makes available a complete line of components designed for Unitrace® which are compatible with conventional piping. With the recent addition of flange, Trace Cap, reducers and elbow fittings to the Unitrace line, it is now possible to design and install complete, fully integrated Unitrace steam-traced piping systems. Unitrace is the revolutionary steam-traced pipe of Alcoa Aluminum. Unitrace incorporates steam and product passages extruded in a single unit of aluminum alloy. It is available in diameters equal to 1½″, 2″, 3″, 4″ and 6″ pipe.

Get complete information on low cost, highly efficient Unitrace components. Write for Bulletin AD418.





New type Unitrace section showing trace line cut back for joint. (Right) Special cast Unitrace flange for easy, efficient joining of new type Unitrace sections.

ALUMINUM COMPANY OF AMERICA

Alcoa Building, Pittsburgh 19, Pennsylvania

and Storage Equipment . . . shall be Alcoa Aluminum to resist corrosion

Alcoa Standard Tanks provide storage economies for a wide variety of chemicals.

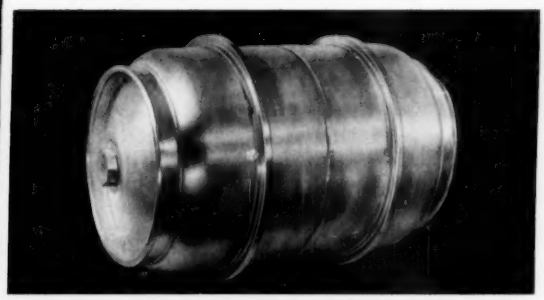
STANDARD AND SPECIAL STORAGE TANKS

Alcoa Standard Storage Tanks are fabricated from 3003 alloy and are available in both horizontal and vertical types in sizes ranging from 5,800 to 21,400 gallons. Because they are made with stocked components, they bring the user all the advantages of light, strong, corrosion-resistant Alcoa Aluminum at lower cost—with fast delivery.

Special storage tanks made of Alcoa sheet and plate can be constructed to meet specific requirements. Design and fabrication data will be furnished on request.

When you write, ask for Bulletin AD387, *Alcoa Standard Storage Tanks.*

World's largest all-aluminum tank stands 26 ft high, has a diameter of 128 ft, holds 2½ million gallons of 83% ammonium nitrate solution.



SHIPPING CONTAINERS

A wide variety of shipping containers conforming to ICC regulations is available from Alcoa. They range in size from 7½ to 110 gallons and are used to ship products ranging from beer to fuming nitric acid.

Lighter in weight than containers of other materials, Alcoa Aluminum containers are less expensive and give substantially longer service.

Aluminum exterior surfaces for buildings and conveyors provide pleasing appearance with minimum maintenance.

ROOFING, SIDING, STRUCTURALS & PAINT

Alcoa Industrial Building Products require practically no maintenance and serve well even when exposed to the corrosive atmospheres often encountered around processing areas. That explains the growing use of aluminum roofing and siding on plant buildings and outdoor equipment. Easily installed, it helps to keep construction costs low.

Alcoa also supplies structural shapes for use in construction where corrosion resistance and consequent low maintenance cost are advantageous.

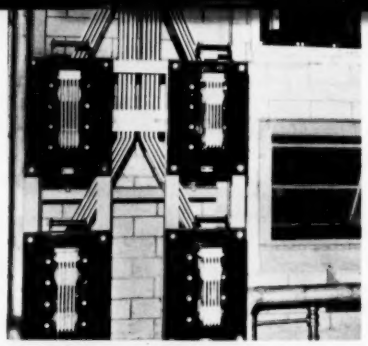
Paints pigmented with Alcoa Aluminum provide a continuous metallic sheet of pure aluminum for unmatched protective power. Where both color and protection are desired, Alcoa supplies nonleafing pigments to paint formulators.

Write for *Alcoa Industrial Building Products* booklet, AD285, *Alcoa Sandwich Walls* booklet, AD625, or *Painting with Aluminum* booklet, AD228.

ALUMINUM COMPANY OF AMERICA

Alcoa Building, Pittsburgh 19, Pennsylvania

SPECIFICATION: *Process Equipment; Plant Structures; Transfer and Storage Equipment . . . shall be Alcoa Aluminum to resist corrosion*



BUS BARS

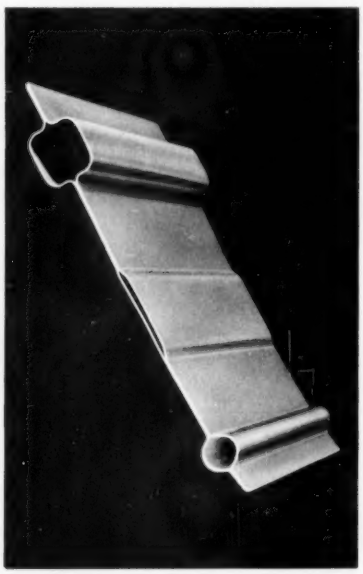
Excellent corrosion resistance, added to lowest cost per unit of current carrying capacity, makes aluminum ideal for bus bar use in process plants. Get complete information by writing for the Alcoa Bus Conductor Handbook, AD661.

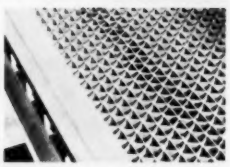
NEW ALCOA EXPANDABLE TUBE-IN-SHEET

Here's a brand new way to bring the outstanding corrosion resistance of Alcoa Aluminum to heat transfer operations. It's Alcoa Expandable Tube-in-Sheet. To produce it, Alcoa has perfected and greatly amplified a revolutionary process for creating tubular shapes as an integral part of aluminum sheet and plate.

These unique, one-piece units of aluminum sheet or plate contain a series of lengthwise, parallel areas that can be expanded hydraulically or with air to form integral tubes in a variety of shapes. Without complicated joining or fabricating, the product is ideally suited to solving heating and cooling problems found in many industrial processes.

Expandable Tube Sheet is available in all nonheat-treatable alloys and in heat-treatable alloys 6061, 2024 and 7075. It is shipped unexpanded in mill finish coiled or flat sheet. Get full information today.





GRATING, STAIR TREADS AND TREAD PLATE

Corrosion-resistant grating-type Alcoa Aluminum stair treads need no paint. They are available in all standard sizes at a price competitive with galvanized steel with abrasive nosing. (Write for Bulletin AD679.)

Aluminum grating is used widely for floors and walkways in and around processing plants because of its light weight, resistance to corrosion, low maintenance and nonsparking characteristics.

Alcoa supplies both a standard aluminum tread plate and Alcoa Abrasive Tread Plate. The latter has a self-renewing, bonded abrasive surface for extra nonskid protection. Write for Bulletin AD596.

ALCOA ENGINEERS WILL HELP YOU WIN THE FIGHT AGAINST CORROSION!

For over 40 years, Alcoa has worked with all segments of the process industries to develop a tremendous variety of applications in which aluminum can be used successfully to resist corrosion. That effort has resulted in an immense fund of practical nonconfidential information covering corrosion characteristics of many materials and processes under a variety of conditions. You can obtain this information without cost or obligation simply by writing Alcoa at the address given below.

When writing, state your requirements as specifically as possible . . . so that Alcoa's development engineers may supply you with the best data.

Write today! Join the thousands who have found Alcoa Aluminum their most important ally in the constant battle against the high cost of corrosion in the process industries.

THIS FREE BOOK

contains 80 pages of detailed data on the performance of aluminum in hundreds of applications throughout the process industries. It provides exact information on the behavior of aluminum with specific materials . . . along with complete design and specification information. Use it as your guide to the proper use of corrosion-resistant aluminum in your plants and equipment. When you write, ask for *Process Industries* Book, AD460.

Aluminum Company of America
903-J Alcoa Building, Pittsburgh 19, Pa.

Please send me the following literature (see above for booklet nos.):

_____

_____

_____

Name _____

Company _____ Title _____

Address _____

City _____ Zone _____ State _____

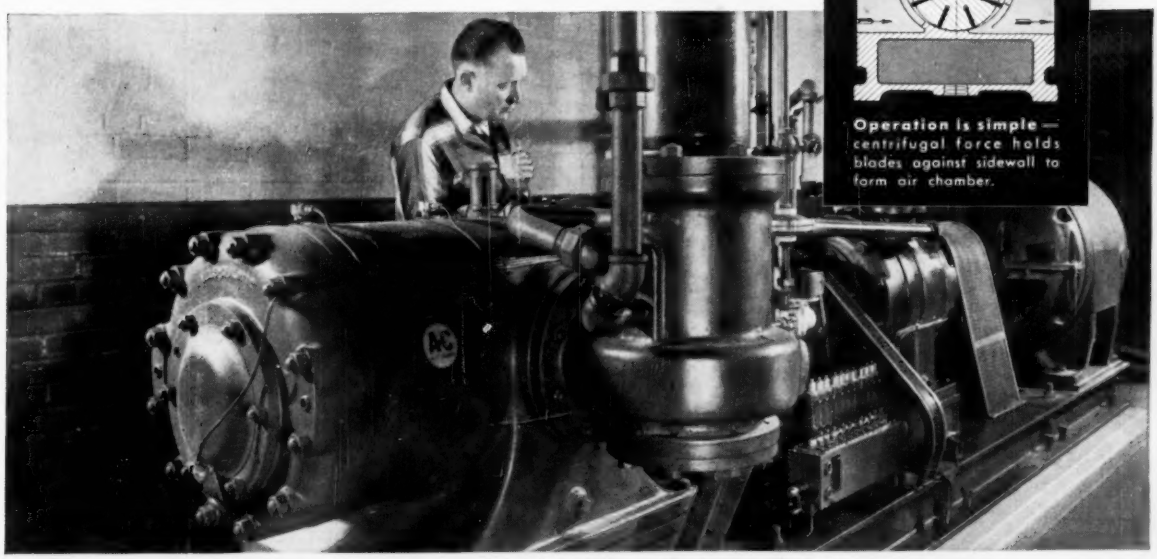
ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

ALCOA THEATRE
Fine Entertainment
ALTERNATE MONDAY EVENINGS

Form 68-11118

Ro-Flo COMPRESSORS

Operation is simple—centrifugal force holds blades against sidewall to form air chamber.



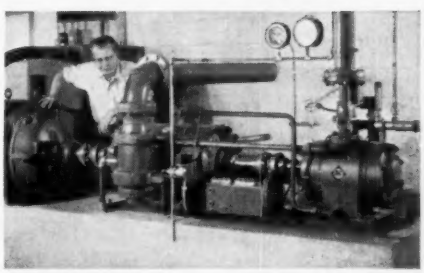
Two-stage rotary compressor supplying plant air for a midwestern manufacturing company.

No shake...no shimmy...no shock!

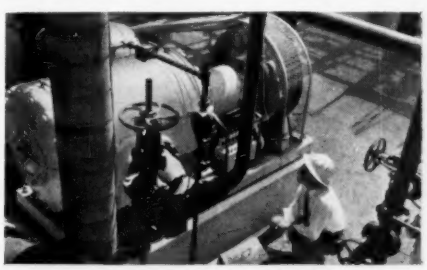
Rotary operation produces a remarkably stabilizing effect. You don't get the shimmy and shock inherent in reciprocating compressors.

Users in many industries have discovered that *Ro-Flo* compressors eliminate the cost of heavy foundations. A simple slab is enough. Smaller units are bolted directly to the floor. Automatic wear compensation at the rotor blades keeps compressor efficiency at high level even after years of use. There are only two wearing parts.

Ratings—Choose from twelve sizes of two-stage *Ro-Flo* compressors, ranging from 250 to 1800 cfm at pressures from 60 to 125 pounds gauge. Single-stage *Ro-Flo* units handle pressures up to 50 pounds gauge, and handle volumes from 40 to 3000 cfm.



Two-stage rotary compressor used for plant air service in a midwestern plant.



Ro-Flo hydrogen compressor in a southwestern plant, used here in conjunction with acrylic monomer process.

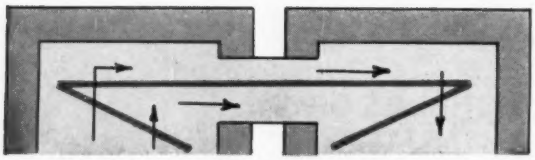
For complete information on Allis-Chalmers rotary compressors, ask for two-stage Bulletin 16B8244 or single-stage Bulletin 16B8126. Call your nearby A-C office or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wis.

Ro-Flo is an Allis-Chalmers trademark.

ALLIS-CHALMERS

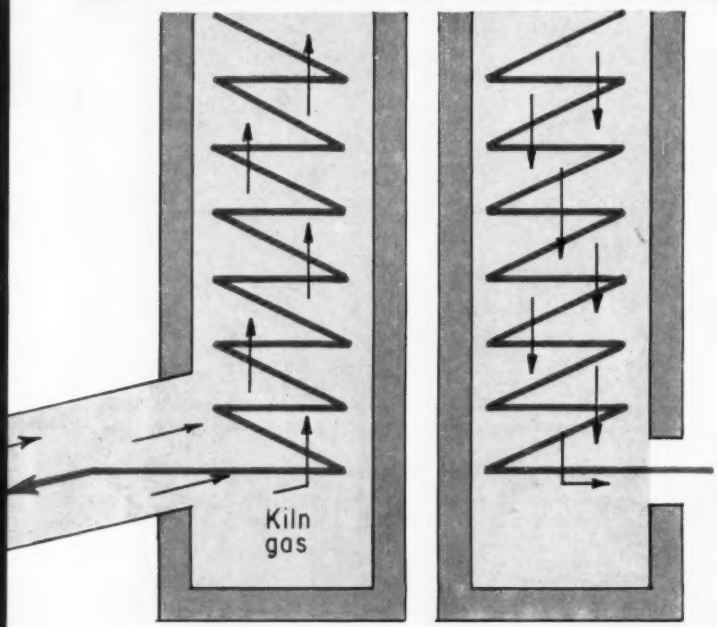
A-C ALLIS-CHALMERS

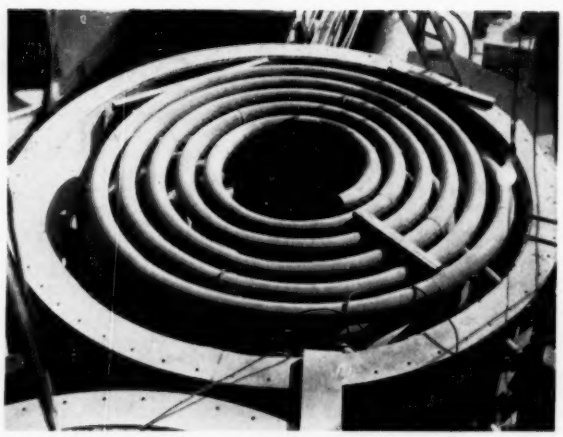
A-5713



PRACTICE . . .

PROCESS FLOWSHEET C. H. CHILTON





Coplay Cement Mfg. Co. is using an unique system to lower unit fuel costs and produce a better cement.

Preheating Cement Kiln Feed Saves Btu.'s

A simple, helical-coil, counterflow heat exchanger is boosting cement production and reducing unit fuel costs for Coplay Cement Mfg. Co., Coplay, Pa.

The exchanger, called the Grudex Preheater, substitutes for feed-end preheating zone of conventional rotary kiln where convection heat transfer is poor (compared with efficient radiation heat transfer in burning zone).

▶ **How To Do It**—The Grudex, invented by Coplay's president, Max Grunewald, and vice president, David Uhle, preheats dry, raw kiln feed by wringing Btu.'s from kiln exit gases. The newest production-line unit at Coplay contains two 2,000-ft.-long coils of 6-in.-I.D. Type 403 stainless steel tubing. The parallel coils are supported by air-cooled beams in two refractory-lined steel shells.

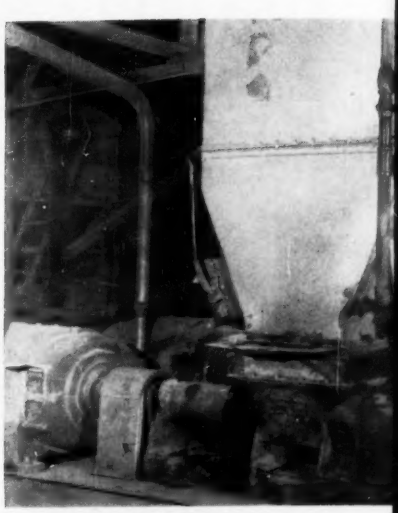
Kiln exit gases, initially at about 1,500 F., pass outside the coils countercurrent to the raw feed. The feed is pumped as a dense-phase, air-fluidized mass inside the tubes, entering the kiln at 950-1,000 F. ready for calcining.

▶ **The Reasons Why**—Two advantages are claimed for the preheater:

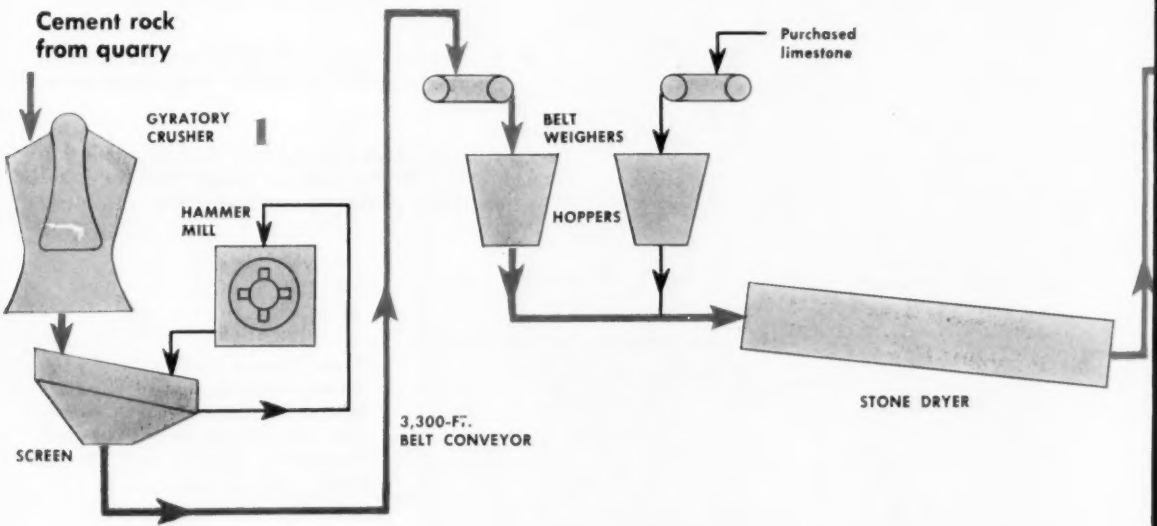
• Unlike the Humboldt and ACL (Lepol) preheaters (*Chem. Eng.*, Oct. 1954, p. 181, and Apr. 21, 1958, p. 60), the Grudex does not allow direct contact of gases with the incoming feed. Effect is

Unfold Flowsheet

1 GYRATORY CRUSHER can handle 400 tons/hr. of natural cement rock. Dumped by quarry trucks, 6-ft. chunks can be reduced to 2-in. size.



2 SOLIDS PUMP'S screw-feed dry ra into it to expand kiln feed through



to prevent volatilized alkalis in gas stream from recondensing on smaller particles of raw feed, leading to undesirable alkali concentrations in product.

(Alkalis are undesirable in a particular cement to the extent that they, in combination with reactive aggregate, affect concrete properties adversely.)

• Second advantage is saving Btu.'s. Tests on Coplay's preheater-equipped, 3,000-bbl./day kiln show that net heat input of only 687,000 Btu./bbl. of clinker is required. This is similar to consumption cited for Humboldt, about 10% higher than that of ACL. It shows vast improvement over rotary cement kilns of 30 years ago that absorbed 2 million Btu./bbl.

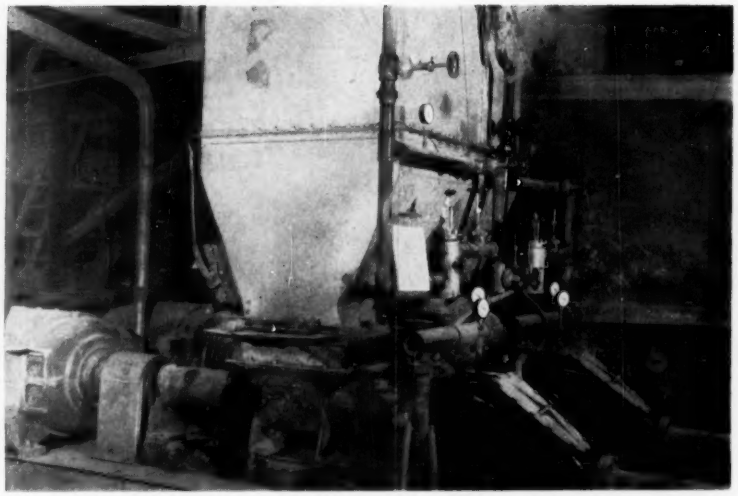
► **Economics of Preheating**—Where once cement makers locked the barn door on large Btu. losses in kiln exit gases by passing the hot gasses through waste-heat boilers, now they attempt to conserve fuel at the input end.

Europeans have been the most active in devising raw-material preheaters, such as the ACL and Humboldt, to perform the latter function. Coplay has found its own Grudex an economic answer.

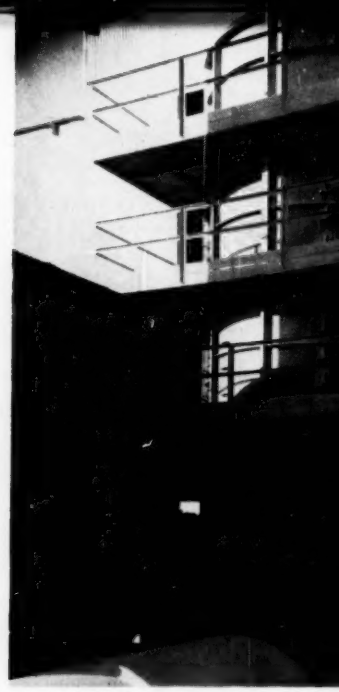
Experience with Grudex preheaters installed on Coplay's kilns shows 40% production increase at same fuel input, resulting in about 37% reduction in unit fuel costs. Increased production is attributed to better heat transfer brought about by substituting turbulent flow of feed through preheater tubing for the slow turnover of material in a kiln that has to do its own preheating.

Coplay has realized an added bonus. Better mixing of feed in the coils shows up in a more homogeneous clinker, one that registers a higher liter weight.

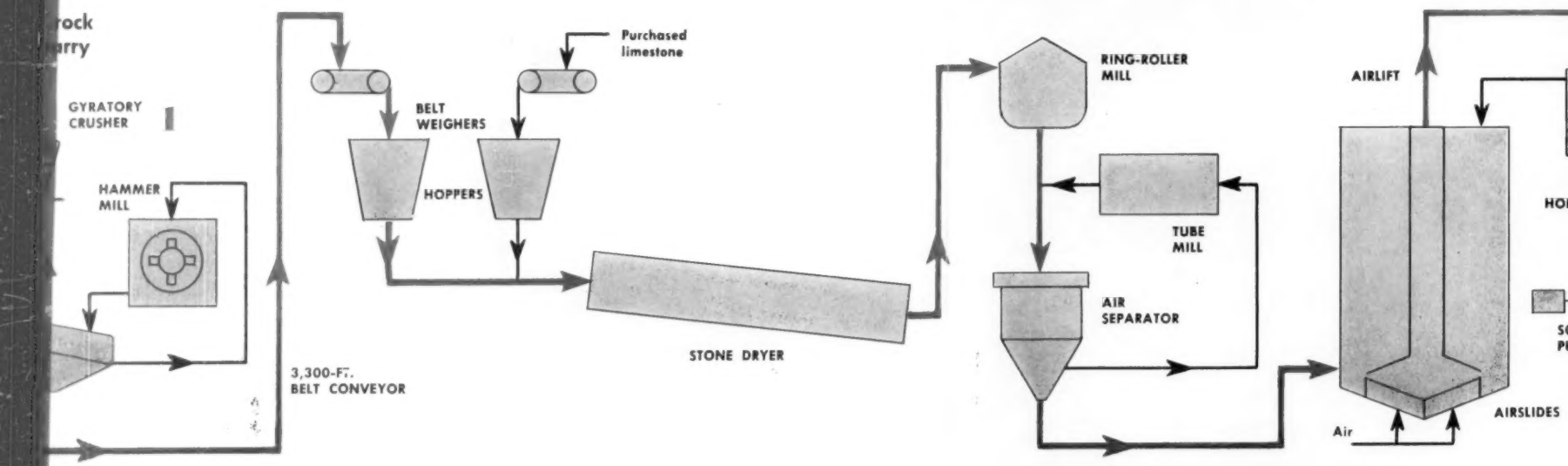
RY CRUSHER can handle 400 tons/hr. of natural cement rock. by quarry trucks, 6-ft. chunks can be reduced to 2-in. size.



2 SOLIDS PUMPS screw-feed dry raw material and inject 60 psig. air into it to expand kiln feed through 2,000 ft. of preheater coils.



3 PREHEATER, installed in 19 provides access for cleaning a



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▶**Who Wants It?**—Kennedy Van Saun Mfg. & Eng. Co., exclusive licensing agent, is negotiating with a half-dozen firms about Grudex installations. Most of these companies have 30-year-old plants and flowlines that include waste-heat boilers and short kilns. That combination of obsolescence and space limitations makes the preheater a natural. Industries other than portland cement also are looking.

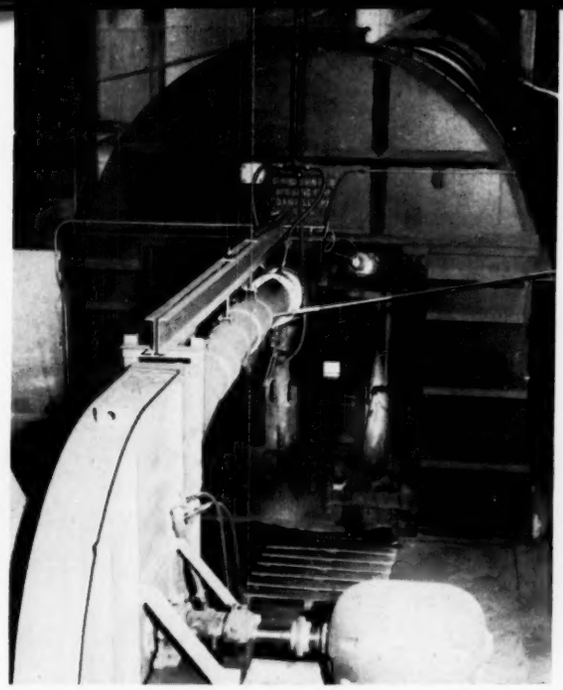
A modification of the preheater includes baffling to direct all the waste gases closer to the tubes, not allowing any to pass up through the relatively large open center channel.

▶**The Recipe**—With 100 ye
proved reserve of natural cem
rock within ¾ mile of its pl
Coplay (first portland cem
manufacturer in the U. S.) ha
process route extending from qua
to boxcar on one site.

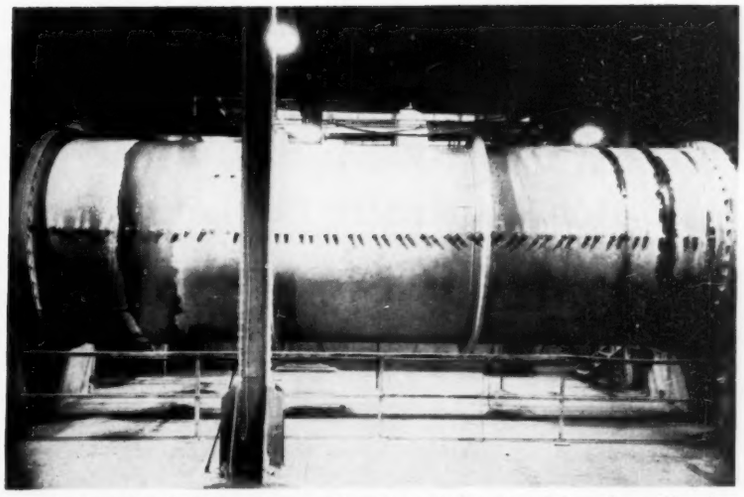
Quarried rock, containing b
limestone and clay, goes first t
48-in. gyratory crusher. Crus
stone then moves to an imp
breaker-vibrating screen circuit
further reduction.

A 30-in.-wide belt conveys
2-in. pieces 3,300 ft. to a st
house. There, weight proportion
adds 10-15% purchased high-gr

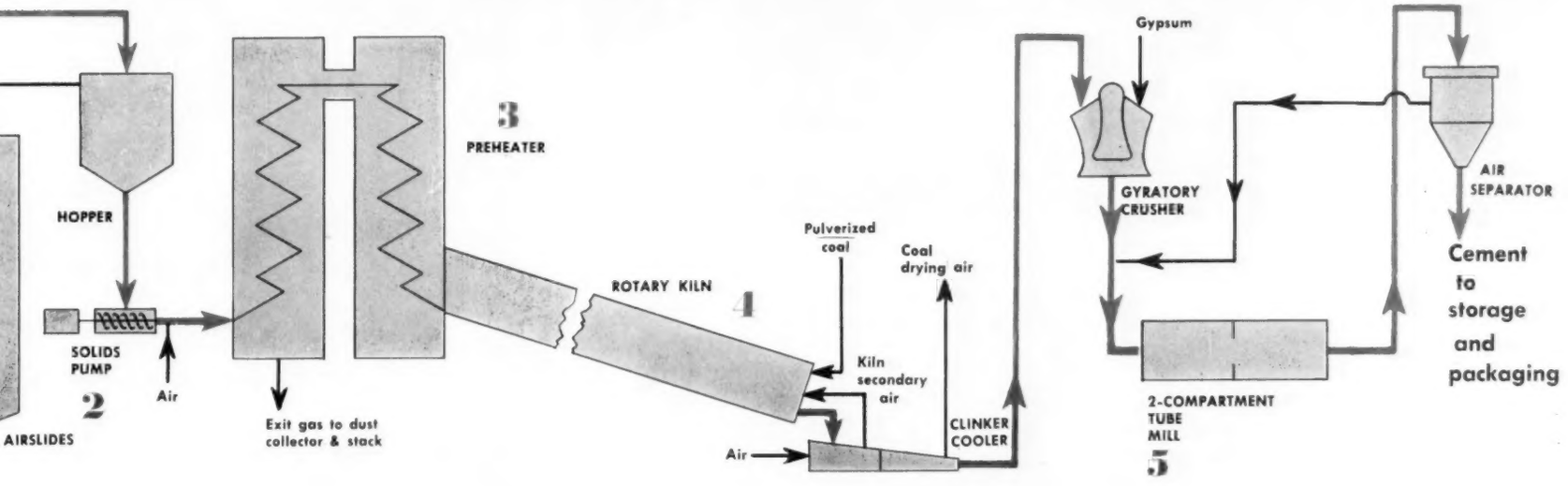
alled in 1955 at cost of $250,000, cleaning and coil replacement.



4 KILN with preheater produces 3,000 bbl./day of clinker in the 3-kiln, 5,000 bbl./day Coplay plant.



5 PRODUCT MILL, a 2-compartment, 9-ft.-dia. by 28-ft. tube mill using 4-in. and 2-in. steel balls, grinds cement before packaging.



100 years' ural cement f its plant, nd cement U. S.) has a from quarry

aining both es first to a er. Crushed an impact n circuit for

conveys the to a stone roportioning l high-grade

limestone to produce a 76% CaO raw feed. Sample tests at three points verify composition.

▶ **Rock To Powder**—The blended mix, after temporary storage in silos, feeds to a rotary dryer that discharges to two ring-roller mills. The mills grind the dry material to 10 mesh; material remains within mills by internal classification until it meets that specification. Further pulverization occurs when the ☆-in. granules feed into four parallel 5½ × 22-ft. tube mills.

The tube mills are in closed circuits with air separators, the underflow fines being 80-82% through 200 mesh. This raw powder feeds to preheater feed tank.

▶ **Making Cement**—Within this tank, fluidized conveyors move the feed to an airlift that elevates it to a constant-head tank which, in turn, overflows back into the preheater feed tank. The head tank feeds downward to two parallel solids pumps.

Within each pump, a screw conveyor, turned by a variable-speed d.c. motor according to feed requirements, forces feed forward into the Grudex preheater. Air at 60 psig. is injected, and the dense solids-air mixture expands, increasing in velocity in the hot coils.

The two parallel circuits discharge to a 11½-ft.-dia., 200-ft.-long rotary kiln, where raw material is calcined and burned to essentially a tricalcium silicate ($3CaO \cdot SiO_2$) clinker. A water-cooled burner fires the 2-rpm. kiln, using pulverized coal prepared by a 9×9-ft. ball mill-classifier circuit that also feeds two other kiln burners.

▶ **After the Kiln**—Kiln exit gas and dust, after passing through the preheater, enter cyclone collectors for cleaning, dust being returned to feed or rejected as conditions demand. Once-a-day air cleaning removes dust from outside of preheater tubes.

Hot clinker discharges from kiln to grate cooler, where heat is recovered for kiln secondary air and coal drying. Weight proportioners add 17 lb. of gypsum ($CaSO_4 \cdot 2H_2O$) per barrel of clinker to act as setting retarder when cement is made into concrete.

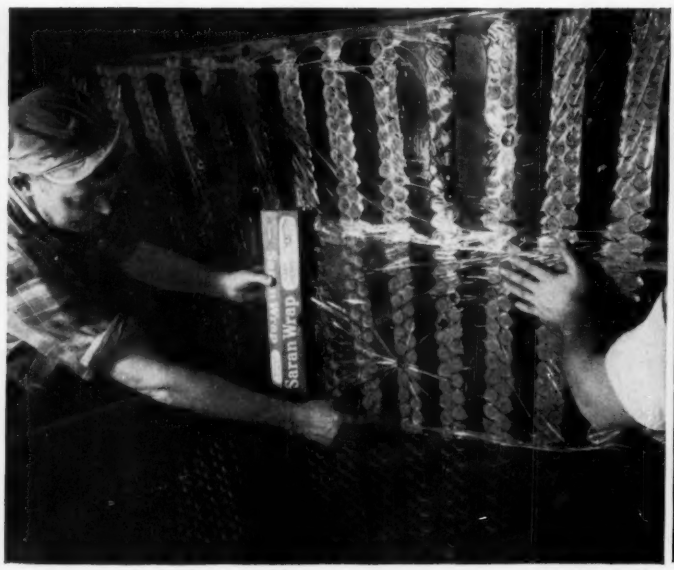
The two materials are crushed in a gyratory, after which a two-compartment, 9 × 28-ft. tube mill grinds it to final product size. Underflow fines from product mill-air separator circuit go to bin storage and packaging.

BRIDGEPORT BRASS

COPPER ALLOY BULLETIN

CONDENSER AND HEAT EXCHANGER TUBE EDITION

Plastic Film Detects Condenser Tube Leaks Without Turbine Shut Down



Maintenance crew spreads plastic film over still-wet tube sheet—a simple, fast operation.

Leaking tube is quickly identified when vacuum inside condenser sucks in plastic film.

A novel and successful method of finding and plugging leaking condenser tubes while the unit is on the line has been developed by operating personnel at the Portsmouth Power Station of Virginia Electric & Power Company, Portsmouth, Virginia. Because this simple method is inexpensive, accurate, and timesaving, it will be of interest to every engineer.

The necessity of a complete shut down to detect a condenser tube leak has now been eliminated and it is possible to take out one half of the condenser successfully, find the leak and return to full capacity 60% sooner than ever before. The key is a plastic film leak detector.

When a tube leak becomes apparent, the condenser is "shot" with sawdust until the leak becomes too difficult to control. At this point the necessary drop in load is scheduled to remove one half of the condenser. Then the condenser is backwashed before taking it off the line to make the leak reappear.

After the circulating water has drained from the leaking half, three operators go into one end of the condenser and cover the entire tube sheet with plastic film. This is most desirable while the sheets are wet. When one end is completely covered, the process is repeated at the other end of the condenser. As vacuum is built up in the leaking tube, the plastic is pulled into that tube showing immediately which tubes are the "culprits." This method has been used many times, returning the condenser to service with one or more tubes plugged and as yet no leak has gone undetected.

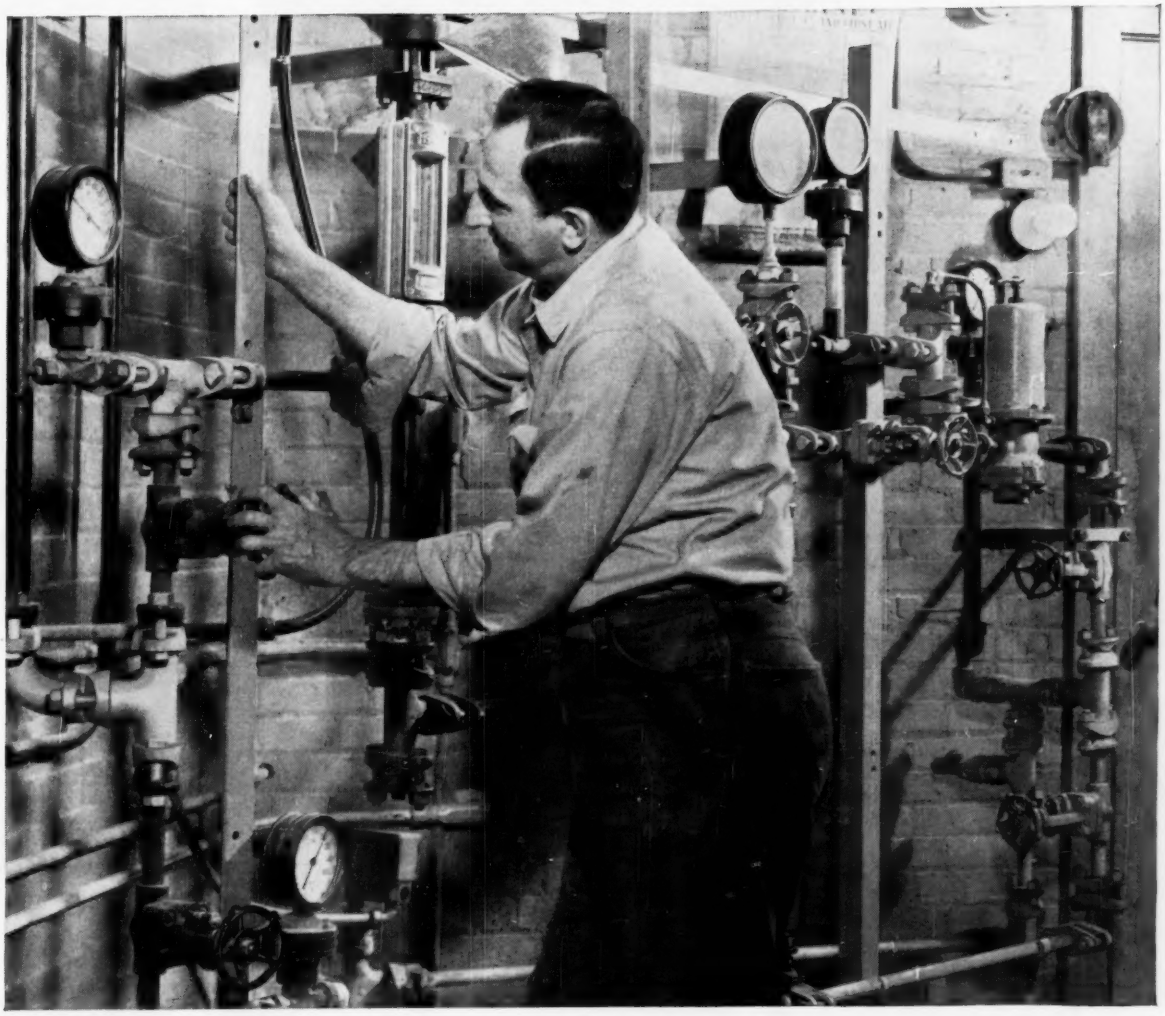
Virginia Electric & Power Company's plastic film "leak-detector" method is an ingenious contribution to condenser and heat exchanger maintenance. It is one of many ideas that Bridgeport Brass has brought to the attention of engineers to insure better, more efficient, more economical operation.

Your Bridgeport Salesman — backed by Bridgeport's Technical Service Staff — is continually in contact with the most recent developments in your field. He is always ready to assist you in problems involving the selection, application and use of condenser and heat exchanger tubes. Call him today.

Bridgeport **BRIDGEPORT CONDENSER TUBES**

Bridgeport Brass Company, Bridgeport 2, Conn. • Sales Offices in Principal Cities

In Canada: Noranda Copper and Brass Limited, Montreal



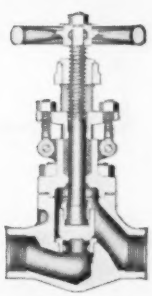
Crane Chlorine Valve Passes 10th Repair-Free Year on Chlorine Gas Throttling

Every time an operator opens or closes the Crane chlorine valve shown above, the Bergstrom Paper Company, Neenah, Wisconsin, is paid another dividend on an investment in service made more than 10 years ago!

This Crane No. 1644 forged steel globe valve is designed especially for chlorine gas or liquid service. In the Bergstrom plant it is used as a throttling valve to control and regulate chlorine gas pressure.

With the exception of a change-over to Teflon packing, this valve has needed no maintenance or repairs in ten years. It operates easily and closes tightly, and permits accurate, close, and safe control of chlorine gas. The record of this and other Crane chlorine valves has led the Bergstrom mill to standardize on the No. 1644 for all chlorine handling.

Ask your Crane Representative about this and other lines of Crane valves for handling hazardous and corrosive chemicals and liquors in your mill.



This rugged forged steel chlorine valve has Hastelloy "C" trim and Teflon packing. Globe or angle patterns; screwed or flanged ends.

CRANE VALVES & FITTINGS

PIPE • PLUMBING • KITCHENS • HEATING • AIR CONDITIONING

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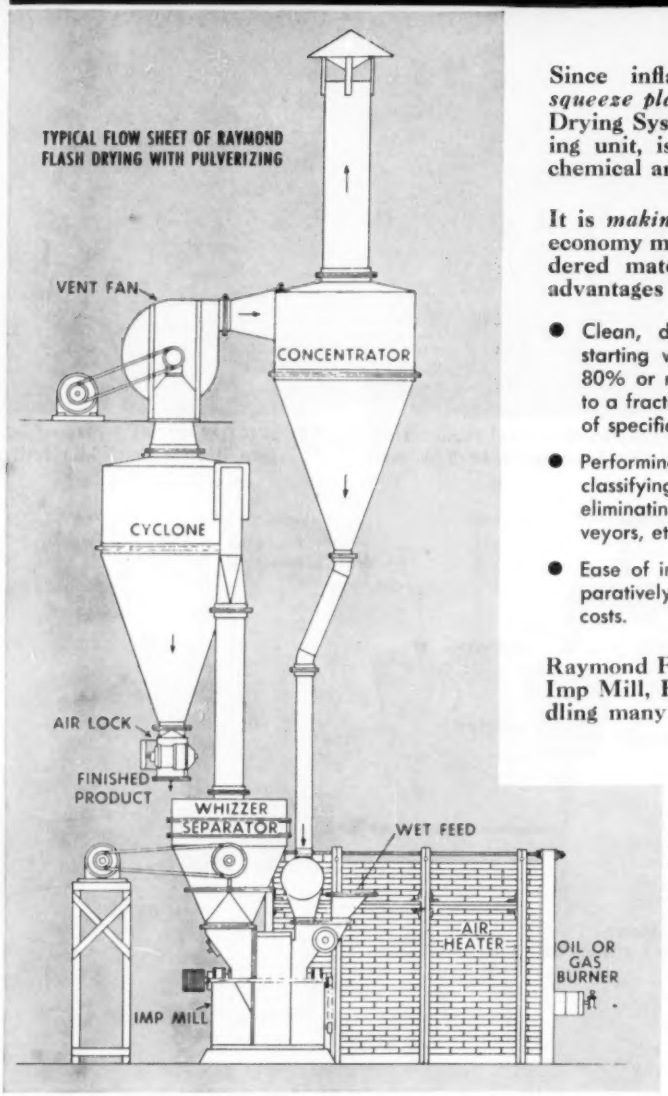
RAYMOND *Flash-Drying* makes the News



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Kiln preheater saves Btu.'s, makes better cement 146

An invention of Coplay Cement Mfg. Co.'s two top execs captures kiln exit-gas heat to enhance fuel economy and product quality in this dry-process cement plant.

Quick plant cost estimates with new cost factors 155

From experience at Monsanto come new cost factors for getting quick and accurate plant cost estimates. All you need is an equipment schedule and unit equipment costs.

Charts help determine pressure drop through tubes . . 160

These new charts save you time and minimize your computations whenever you must calculate pressure drop for turbulent flow through tubular heat-exchanger tubes.

Environment modification aids corrosion control 163

Consider these factors: pH, oxidizing agent content, temperature and velocity of corroding medium, inhibitors and cathodic control for practical analyses of corrosion problems.

What to do until the data arrive 169

In this issue we begin a new major section of our award-winning series of articles on estimation of engineering properties. Now, methods for low-pressure gas viscosity.

Use this measure on engineering effort 173

Formalized systems of job evaluation can sometimes lose sight of the individual engineer. Here's a scheme that will help you measure the man in his particular job.

Here's an easy way to order mechanical seals 178

There's more to ordering a mechanical seal than meets the eye. Make use of the seal vendor—he's a big help in solving even your toughest problems.

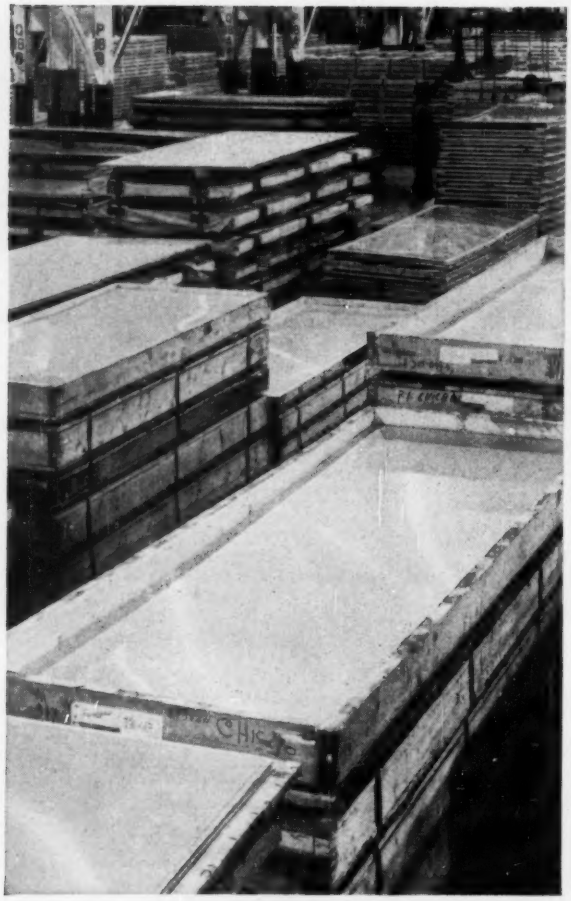
Yardsticks for life of graphite equipment 184

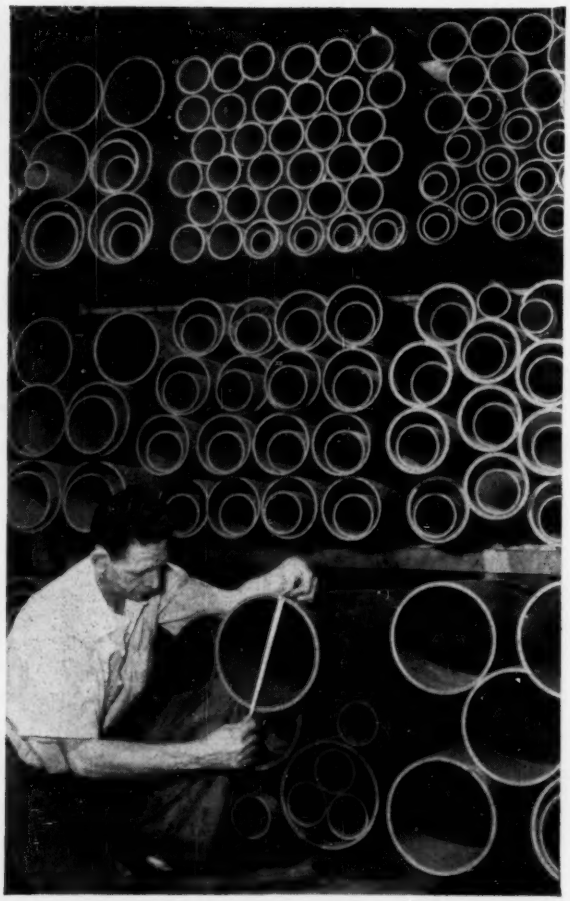
Here is some hard-to-come-by-information: What you can expect in repairs and maintenance on impervious graphite heat exchangers for mild and severe corrosive conditions.

SEPT. 22, 1958

Department Index

Process Flowsheet 146
Feature Articles 155
You & Your Job 173
Design Notebook 175
Operation & Maintenance 178
Corrosion Forum 184





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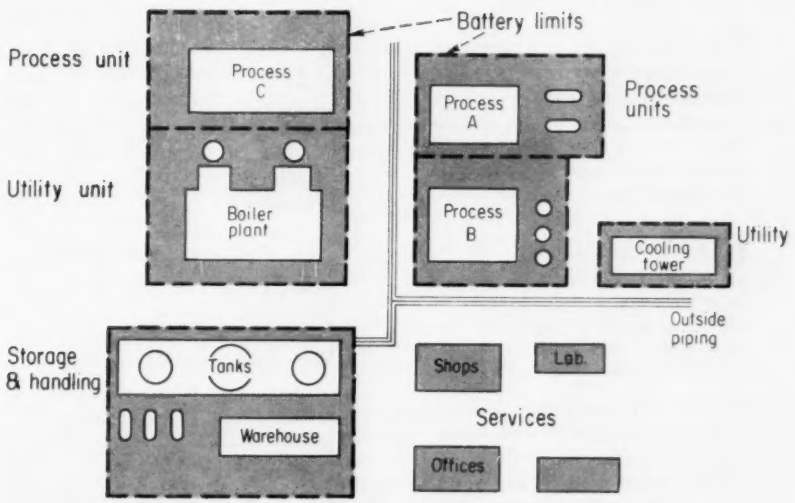
Chemical Engineering
SEPTEMBER 22, 1958



HOW TO GET . . .

More Accurate Plant Cost Estimates

You can quickly come up with a fairly accurate fluid-processing plant cost estimate using these new Monsanto Chemical ratio cost factors.

NORMAN G. BACH, Senior Estimator, Monsanto Chemical Co., Texas City, Texas.

Ratio estimating is a simplified approach to preliminary capital cost estimates. It's a low-cost, fast technique which gives approximate answers.

Lang[1, 2, 3] first presented this idea of using factors or ratios which can be multiplied against equipment costs to get completed plant costs. In most cases where this technique is used the estimator only has an equipment schedule available. Equipment items which are to go into a new plant can be estimated by unit cost methods (quotations, published information, etc.).

Continuous use of these ratio factors has pointed up the need for improvements. First we recommend a modification of the factors based on our experience at Monsanto. Another improvement is the substitution of new factors based on a breakdown of plant items for obtaining a more accurate cost estimate.

Our experience has been with fluid-processing plants, so we have not attempted any modifications of Lang's factors for fluid-solids or solids-handling chemical plants.

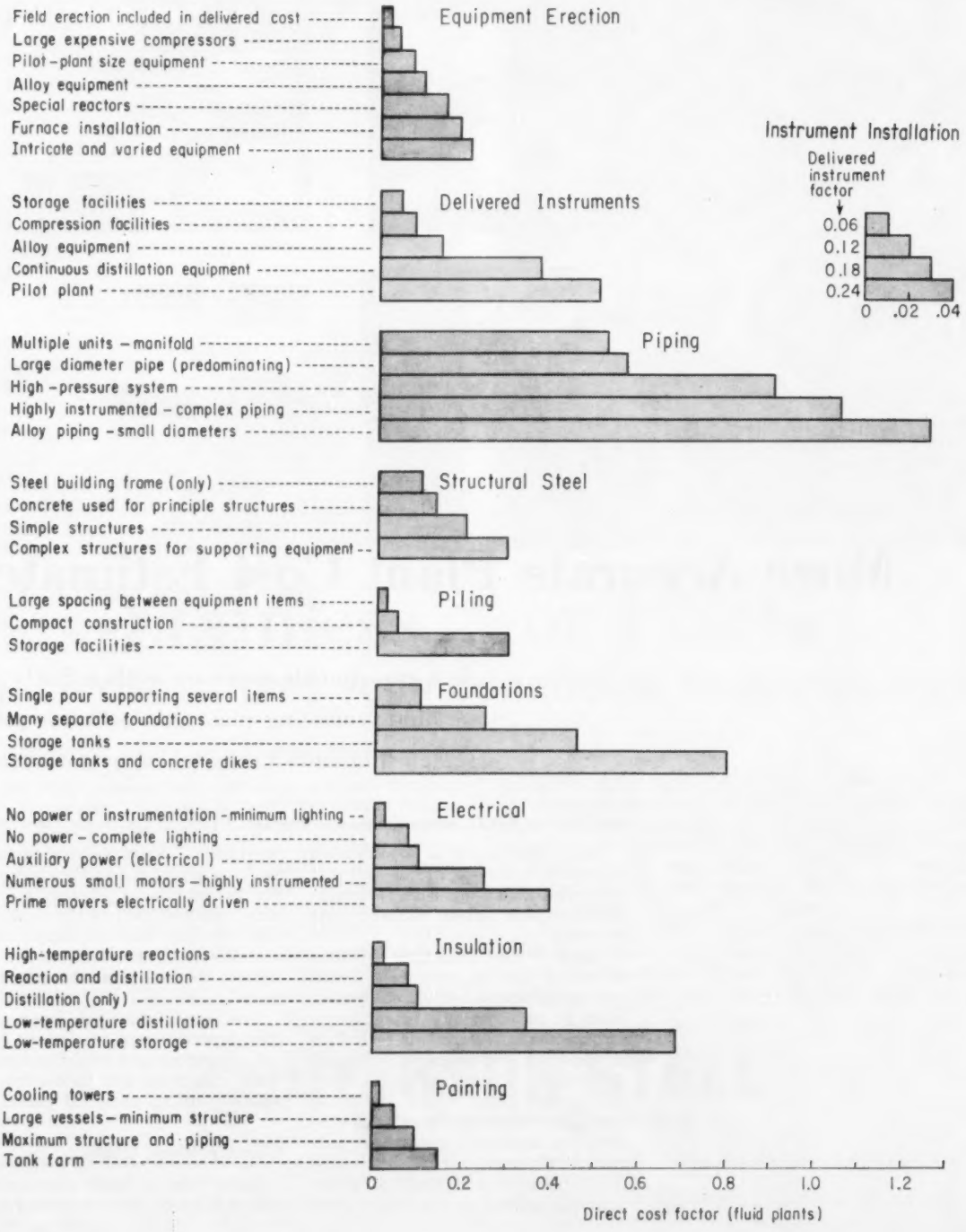
Classify Plant Units

Let's take a fresh approach to this subject by first reviewing some

Select the Correct Cost Factors for Your Particular Plant Design

Simplified Code of Accounts

1. Delivered equipment
2. Equipment erection
3. Delivered instruments
4. Instrument installation
5. Above ground piping
6. Underground piping
7. Structural steel
8. Building items
9. Piling
10. Foundations
11. Electrical
12. Insulation
13. Painting
14. Yards, roads, site preparation



classifications and definitions. Some preliminary studies by technical committees of the American Association of Cost Engineers have been of considerable help. Tentative definitions of the components of a complete plant currently under study by AACE are illustrated in the map (p. 155) of a hypothetical plant.

Principal elements of this plant include Battery Limits (BL) facilities for Process Units, Utility Units, Storage and Handling Units, and Services and other facilities outside of BL. BL may be defined as a "geographic boundary, imaginary or real, enclosing a plant or unit."

In addition to the solid and fluid groups it appears that other classifications such as Electrolytic Process Units might be added.

Disadvantages of Ratio Factors

Some cost engineers engaged in competitive estimating frown on the use of ratio estimating because of its inherent lack of accuracy. The Lang factor for fluid process plants is listed as 4.74 but our experience with several multimillion dollar plants has found this factor varies from 3.58 to 5.05. Nichols has shown that estimates made by the Lang method may be from 30% lower to 20% higher than actual costs.[4]

The Lang factors include indirect construction and engineering costs plus those for service facilities. Such costs have little bearing on equipment costs. Indirect costs vary with contracting methods and over-all magnitude more than they do with equipment costs. Except for a complete new plant, service facilities cannot be related to equipment costs, and even with a new plant, service facilities are dependent on the size of over-all investment.

Although not as significant, all ratio estimates assume that cost indexes are the same for all plant components. It has been brought out that indexes vary for dissimilar items.

Advantages of Ratio Estimates

In spite of these disadvantages and lack of precision, ratio estimating is widely used because it is cheap and fast. In some cases it is the only practicable method to use. Ratio estimating can be used in many phases of capital cost estimating. This can be done with a minimum expenditure of engineering time. In addition, ratio estimating data does not go out of date as does unit cost data. The Lang articles published in 1948 are still up-to-date.

Modified Lang Factors

By using BL classifications and excluding indirect costs, modified Lang factors have been developed for fluid-processing plants:

	Fluid Plant Factor
Process unit BL	2.3–4.2
Utility unit BL	1.7–2.6
Storage unit BL	2.8–4.8

There are important gaps left to be filled in by cost engineers familiar with solids and electrolytic process plants.

When using the modified factor, the cost of services and facilities outside of BL will have to be estimated by other methods. Indirect costs can be estimated by ratios to total direct costs as O'Donnell recommends[5] or by unit costs, or a combination of both methods.

Improved Factoring Method

We also use another method which gives more accurate answers then the Lang factors. Called a "work category" technique, it also uses factors. However, these factors, when applied to equipment costs, give the cost of each of the major categories of work or expenditure. Total direct plant cost is the sum of the major categories.

In applying this method it is necessary to make a breakdown of cost elements, or categories, within each BL. This is referred to as a code or classification of accounts. The code used in this factoring method should be very simple. In practice it would be the outline or a skeleton of the code of accounts actually used during construction. Such a code might include as a minimum the items shown on the table. Gilmore has prepared an excellent code which, when used in a simplified form, fulfills these requirements.[6]

By using a code when making a ratio estimate, it is possible to have more flexibility in applying judgement to the factors.

Extra amount of engineering design and estimating time required for the application of several ratios instead of one, as in the Lang technique, is insignificant.

The large table gives factors for each code category. These factors are established from actual Monsanto direct costs tabulated over the past few years. A study of the data has revealed that the over-all cost of the unit does not significantly affect the cost ratios. However, such ratios should be used with caution for plants costing less than $100,000 to $200,000.

Use of these ratios for plant alterations (and additions) is questionable. The table on p. 158 gives examples for large expenditures in altering existing units. Ratios within certain categories show considerable variations.

Why Use Improved Method?

Worthwhile improvements are made by breaking down the costs of a unit into several categories when preparing a preliminary capital estimate. These improvements are both in accuracy and scope. More important, from the estimator's viewpoint, is that this method permits immediate use of engineering data which has to be ignored in the Lang factor method. If it is known that no buildings are required, the factor for this item becomes zero. If complete flow sheets showing instrumentation are available, it may be desirable to estimate the cost of each instrument and not depend on factors for the instrumentation items.

Choosing the Factor

Selection of the correct factor is a problem in any ratio estimate. Experience gained from actual costs is invaluable.

A graphic analysis of the ratios for most categories in the table is given in the charts. Conditions influencing the low and high factors are shown.

The charts are set up so you can use some judgment in selecting an accurate factor for each category.

As calculated from the table, the average factor for equipment erection is 0.13. This is for an "average" fluid processing plant with a minimum of alloy equipment, intricate piping, etc. If equipment is of alloy construction the factor as shown will be less than average

Typical Direct Cost Factors from Monsanto's Fluid Processing Plants

	Unit	Delivered Equipment	Equipment Erection	Delivered Instruments	Instrument Installation	Above Ground Piping	Underground Piping	Structural Steel	Building Items	Piling	Foundations	Electrical	Insulation	Painting	Yards, Roads and Site Preparation	Modified Lang Factor
Battery Limit Process Units																
	1	1.00	0.08	0.49	0.04	0.94	....	0.07	....	....	0.11	0.29	0.11	0.07	0.02	3.22
	2	1.00	0.12	0.19	0.04	1.19	0.01	0.22	....	0.04	0.34	0.26	0.04	0.06	0.02	3.53
	3	1.00	0.14	0.22	0.04	1.36	0.03	0.21	....	0.01	0.28	0.30	0.03	0.06	0.01	3.69
	4	1.00	0.13	0.26	0.03	1.16	....	0.15	0.08	0.02	0.08	0.11	0.29	0.04	0.02	3.37
	5	1.00	0.17	0.14	0.03	0.57	....	0.10	0.01	0.03	0.14	0.12	0.04	0.03	0.05	2.43
	6	1.00	0.05	0.06	0.01	0.63	0.04	0.10	0.06	0.02	0.12	0.08	0.09	0.03	0.03	2.33
	7	1.00	0.10	0.12	0.02	0.91	....	0.20	0.07	0.02	0.06	0.08	0.07	0.04	0.03	2.72
	8	1.00	0.13	0.34	0.03	1.16	....	0.32	0.04	0.03	0.26	0.22	0.43	0.09	0.07	4.12
	9	1.00	0.13	0.11	0.01	0.48	0.04	0.19	0.06	0.01	0.12	0.10	0.10	0.02	0.03	2.40
	10	1.00	0.14	0.16	0.01	0.73	0.02	0.19	0.09	0.05	0.15	0.25	0.11	0.02	0.04	2.96
	11	1.00	0.15	0.24	0.04	1.00	....	0.11	0.19	0.06	0.11	0.40	0.06	0.06	....	3.42
	12	1.00	0.16	0.14	0.02	0.90	0.01	0.28	0.19	0.05	0.17	0.20	0.08	0.07	0.08	3.35
	13	1.00	0.19	0.17	0.02	0.98	....	0.28	0.06	0.05	0.14	0.17	0.06	0.05	0.03	3.20
Battery Limit Utility Units																
	1	1.00	0.05	....	....	0.18	0.63	....	....	0.05	0.34	0.31	....	0.01	....	2.57
	2	1.00	0.02	....	....	0.20	....	0.07	....	0.05	0.21	0.18	0.02	0.02	....	1.77
	3	1.00	0.04	0.04	....	0.10	0.14	....	....	0.04	0.20	0.14	....	0.01	....	1.71
	4	1.00	0.04	....	....	0.36	0.03	0.01	....	0.06	0.19	0.12	0.03	0.01	....	1.85
	5	1.00	0.02	0.02	....	0.31	....	0.05	....	0.07	0.22	0.17	0.02	0.01	....	1.89
	6	1.00	0.19	....	....	0.26	0.02	....	....	0.09	0.33	0.26	0.01	0.01	....	2.17
	7	1.00	0.05	0.03	....	0.53	0.02	0.09	....	0.09	0.33	0.24	0.05	0.03	....	2.46
	8	1.00	0.33	0.12	0.01	0.65	0.02	0.08	0.05	0.03	0.10	0.11	0.06	0.05	....	2.61
Battery Limit Storage and Handling Facilities																
	1	1.00	0.08	0.06	0.01	0.79	0.03	0.27	....	0.14	0.36	0.12	....	0.10	....	2.96
	2	1.00	0.02	....	....	0.51	0.21	....	....	0.43	0.31	0.03	....	0.06	0.03	2.60
	3	1.00	0.13	0.03	....	0.44	0.58	0.15	....	0.36	0.92	0.26	0.69	0.15	0.11	4.82
	4	1.00	0.02	....	....	0.14	0.08	....	....	0.55	0.39	0.07	....	0.04	0.14	2.43
	5	1.00	0.08	0.10	....	1.51	0.11	0.49	....	0.07	0.43	0.40	0.12	0.18	0.10	4.59
	6	1.00	0.06	0.07	0.03	0.56	0.16	0.30	0.04	0.23	0.47	0.12	0.08	0.06	0.08	3.26
Additions and Alterations to Existing Units																
	1	1.00	0.13	0.06	0.01	0.65	....	0.01	....	....	0.01	0.04	....	0.02	....	1.93
	2	1.00	0.02	0.10	....	0.82	0.10	0.08	....	0.03	0.67	0.08	....	0.04	0.03	2.97
	3	1.00	0.13	0.58	0.09	2.25	0.02	0.25	....	0.19	0.21	0.22	0.13	0.06	0.04	5.17
	4	1.00	0.15	0.03	0.03	0.57	....	0.26	....	0.02	0.08	0.24	0.06	0.03	....	2.47
	5	1.00	0.04	0.09	0.02	1.32	....	0.37	0.01	0.02	0.06	0.11	0.37	0.04	....	3.45

Typical Equipment Ratios in Distillation Units

	Unit				Weighted Average
Unit No.	1	2	3	4	
Exchangers	33	48	29	28	33
Pumps	10	06	06	16	10
Tanks	16	15	06	03	08
Towers	41	31	59	53	49
	100%	100%	100%	100%	100%

at about 0.10. If complex, special reactors are included the factor will be 0.15. Where both conditions exist the ratio would be between the two or at 0.13.

Delivered Equipment

Since all other costs are based on equipment costs as unity, it would appear that ratios would not be applicable between types of equipment. However, for a given type of BL process unit, ratios can be established between equipment types. An example of this application to distillation units is given in the table above.

Indirect Costs

As most cost engineers know the defining of indirect costs is difficult. In excluding indirect costs in this article, they have been defined to include costs which may be considered indirect by both engineering contractors and by the owner-operators of the process units.

Although indirect costs (engineering, payroll burden, fees, temporary facilities, etc.) cannot be satisfactorily determined directly from delivered equipment costs, they can be developed. O'Donnell[6] has suggested a method for estimating indirect costs based on percentages of the total plant costs.

Interim Summary

The data presented in this article represents considerable experience of the writer's company. Addition of actual experience of others and of further definition of variables affecting ratios would be a welcome addition to the total published knowledge for the use of all engineers.

Let's Work Examples

To illustrate use of the "work category" ratio factors, lets take a typical situation. It is proposed to add Process C to our facilities (see map). This will consist of some distillation towers and auxiliary equipment handling flammable fluids. There are no abnormal pressures or temperatures. Also there's no alloy or unusual equipment although the process is fully instrumented. Estimated delivered costs are as follows:

Equipment	$375,000
Instruments	48,000
Control house building	45,000

Our factors for each category are tabulated:

Delivered equipment	1.00
Equipment erection	0.13
Delivered instruments	0.13
Instrument installation	0.02
Above ground piping	0.95
Underground piping	0.01
Structural steel	0.20
Building items	0.12
Piling	0.05
Foundations	0.20
Electrical	0.25
Insulation	0.10
Painting	0.10
Yards, etc	0.03

These factors give a total direct cost of $1,236,000. Note that most of the factors are average. However, since the unit is mainly distillation the insulation factor is 0.1.

Also note that the factors for instruments and building items were from known dollar values. The underground piping and yards factors were calculated from judgment allowances.

Total cost of the project requires addition of indirect costs, which may be obtained from curves by O'Donnell.[6] This would result in indirect costs of $540,000 or a total plant cost of $1,776,000.

As another example let's assume we want to install a cooling tower (forced draft) with circulating pumps. Estimated delivered cost of pumps and drivers and erected cost of cooling tower is $80,000. Our factors would look like this:

Delivered equipment	1.00
Equipment erection	0.02
Delivered instruments	0.00
Instrument installation	0.00
Above ground piping	0.50
Underground piping	0.00
Structural steel	0.01
Building items	0.00
Piling	0.05
Foundations	0.20
Electrical	0.15
Insulation	0.00
Painting	0.01
Yards, etc	0.01

Here total direct costs come to $157,000. Note that the factor for yards was based on a known dollar amount for this type of work.

NORMAN BACH *was one of the driving forces behind the recent organization of the American Association of Cost Engineers. He is a founding member and holds the distinction of being the first elected president of that association (now past president).*

Mr. Bach is senior estimator in charge of the estimating group at Monsanto's Texas City plant.

He attended MIT, Tufts and Northeastern. Starting with Monsanto in 1935 *in control laboratory work, he transferred to the Engineering Dept. in* 1942 *and went to Monsanto's ordnance works at Marshall, Tex. After becoming an area engineer he transferred to estimating work at Everett, Mass., then came to Texas City in* 1947.

Mr. Bach is an active amateur radio operator (his car is outfitted with a short-wave radio) and he's served as president of the Galveston County Amateur Radio Club.

ACKNOWLEDGMENT

Special thanks are due to John M. Chamberlin, Tom Ford, E. L. Halle and Ray Hopkins, all at Monsanto, for their help in the preparation of this material.

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Speed Pressure Drop Calculations

For turbulent flow through tubes, here is a new method that gives rapid evaluation of pressure drop for tubes in tubular heat exchangers and requires a minimum number of calculations.

NING HSING CHEN, Heat Transfer Div., M. W. Kellogg, Jersey City, N. J.*

By using these charts, we can easily find a fairly accurate value of pressure drop through the tubes of a tubular heat exchanger. The conventional method to find pressure drop is to calculate the Reynolds number. Then to obtain the friction factor corresponding to this Reynolds number from Moody's chart[1] or other charts.[2,5] Finally, we substitute this friction factor and other quantities into the Fanning equation.[5] Hence the usual method is quite tedious and time consuming. A typical problem shows how to use these charts to find pressure drop in a very short time.

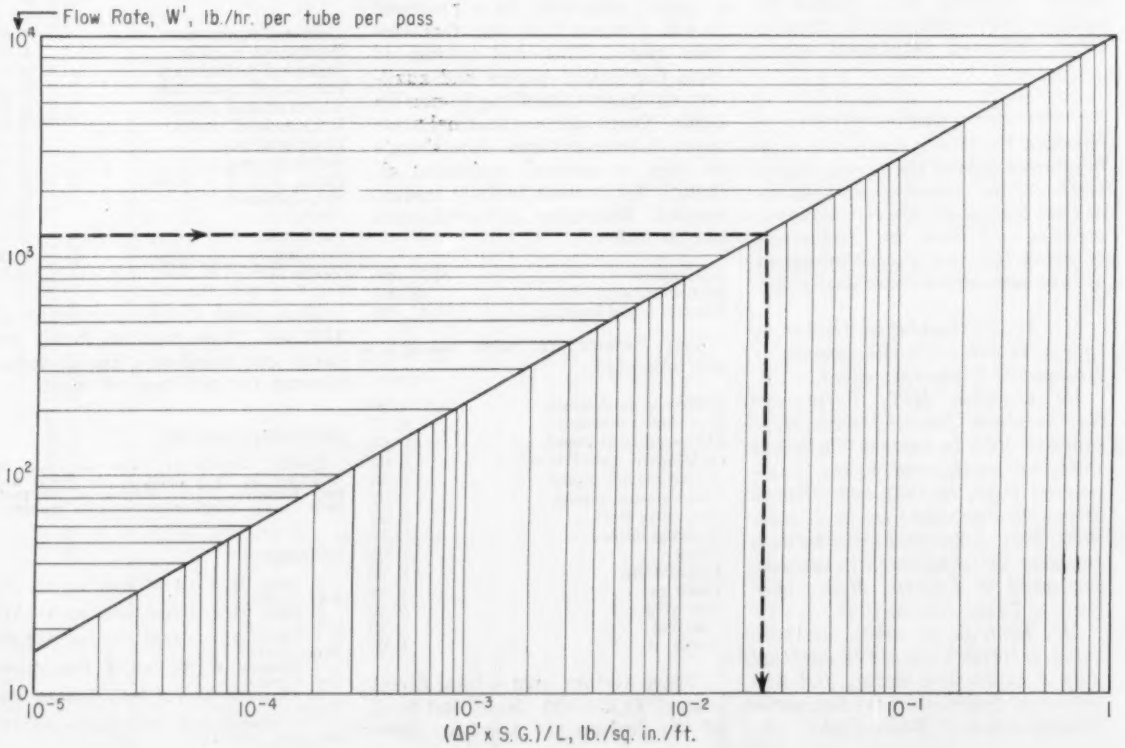
* To meet your author, see *Chem. Eng.*, June 30, 1958, p. 140.

Example Illustrates Use of Charts

Problem—Find the pressure drop through the tubes of a tubular heat exchanger for a liquid flowing isothermally at a rate of 168,000 lb./hr. through a 1-2 exchanger. The exchanger has 270 tubes each ¾ in. x 14 BWG., 16 ft. long and has 2 tube passes. At the average operating temperature, the viscosity of the liquid is 0.85 centipoise and the specific gravity of the liquid is 1.07.

Two steps are necessary to calculate the required pressure drop through the tubes of this tubular heat exchanger.

Start here to find uncorrected pressure drop function, Fig. 1



Step 1—We first find the value of $(\Delta P' \times S.G.)/L$ from Fig. 1 by calculating the flow rate per tube per pass. The flow rate equals 168,000/(270/2) = 1,240 lb./hr.

Draw a line through flow rate of 1,240 to intersect the straight line on the chart. Read the uncorrected value for $(\Delta P' \times S.G.)/L$ from the horizontal scale. Multiply this value by the viscosity correction factor F_z which is shown in Fig. 2 and also by the tube size correction factor $F_{D'}$ shown at the bottom of Fig. 2.

Value of F_z for 0.85 centipoise is 0.97 and $F_{D'}$ is 1.34. Therefore, the corrected $(\Delta P' \times S.G.)/L = 0.025 \times 0.97 \times 1.34 = 0.0325$.

Step 2—Next we find $\Delta P'$ in psi. from Fig. 3. Draw a line horizontally where $(\Delta P' \times S.G.)/L = 0.0325$ to meet the line drawn vertically from $L = 32$ ft. which equals 16 ft. × 2 passes. Through this intersection draw at 45° a line which is parallel to the guide line on the chart to meet the line drawn vertically through specific gravity of 1.07.

The ordinate of this last intersection is the required pressure drop which equals 0.97 psi. If we use a safety factor of 1.25, then the pressure drop of the fluid flowing through the tube only is 1.21 psi.

Charts Developed From Basic Equations

The pressure drop calculation is based on the well known Fanning equation which is:

$$\Delta P = \frac{2fL\,(G')^2}{gD\rho} \qquad (1)$$

For turbulent flow, the relationship between the friction factor and Reynolds number has been investigated by many engineers. Several empirical expressions have been developed. One of the simplest of these expressions[3] which holds with a fair degree of accuracy for flow in tubes in commercial tubular heat exchangers is:

$$f = \frac{0.046}{(DG/\mu)^{0.2}} \qquad (2)$$

Note that Eq. (2) is for flow for Reynolds numbers from 5,000 to about 200,000.

By substituting Eq. (2) into Eq. (1) and converting to common engineering units, we get the following equation:

$$\frac{\Delta P' \times S.G.}{L} = \frac{6.85\,(W')^{1.8}\,Z^{0.2}}{10^9\,(D')^{4.8}} \qquad (3)$$

We use Eq. (3) to make the charts.

Nomenclature

D	Inside tube diameter, ft.
D'	Inside tube diameter, in.
f	Friction factor, dimensionless
$F_{D'}$	Tube size correction factor $= (0.62/D')^{4.8}$
F_z	Viscosity correction factor $= Z^{0.2}$
g	Gravitational constant, 32.2 ft./sec.^{2}
G	Mass velocity inside tube, lb./hr.-sq.ft.
G'	Mass velocity inside tube, lb./sec.-sq.ft.
L	Length of travel, ft.
$S.G.$	Specific gravity
W'	Flow rate per tube per pass, lb./hr.
Z	Viscosity, centipoise.
ΔP	Pressure drop, lb./sq.ft.
$\Delta P'$	Pressure drop, lb./sq.in.
μ	Viscosity, lb./hr.-ft.
ρ	Density, lb./cu.ft.

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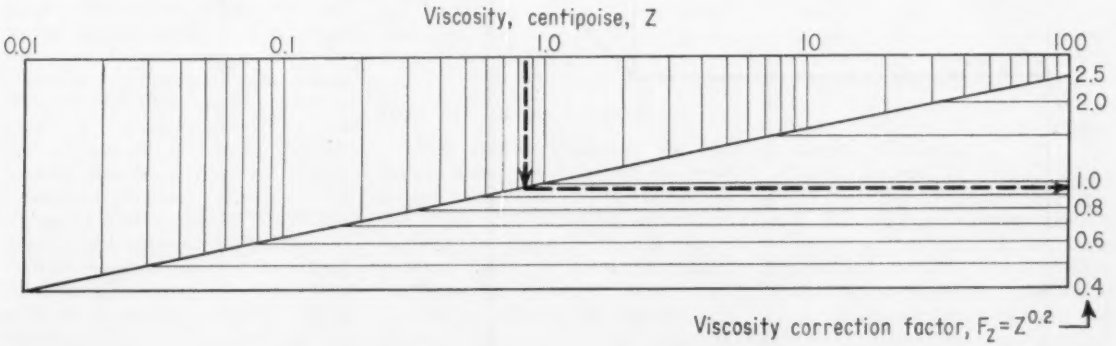
Correct pressure drop for viscosity, Fig. 2

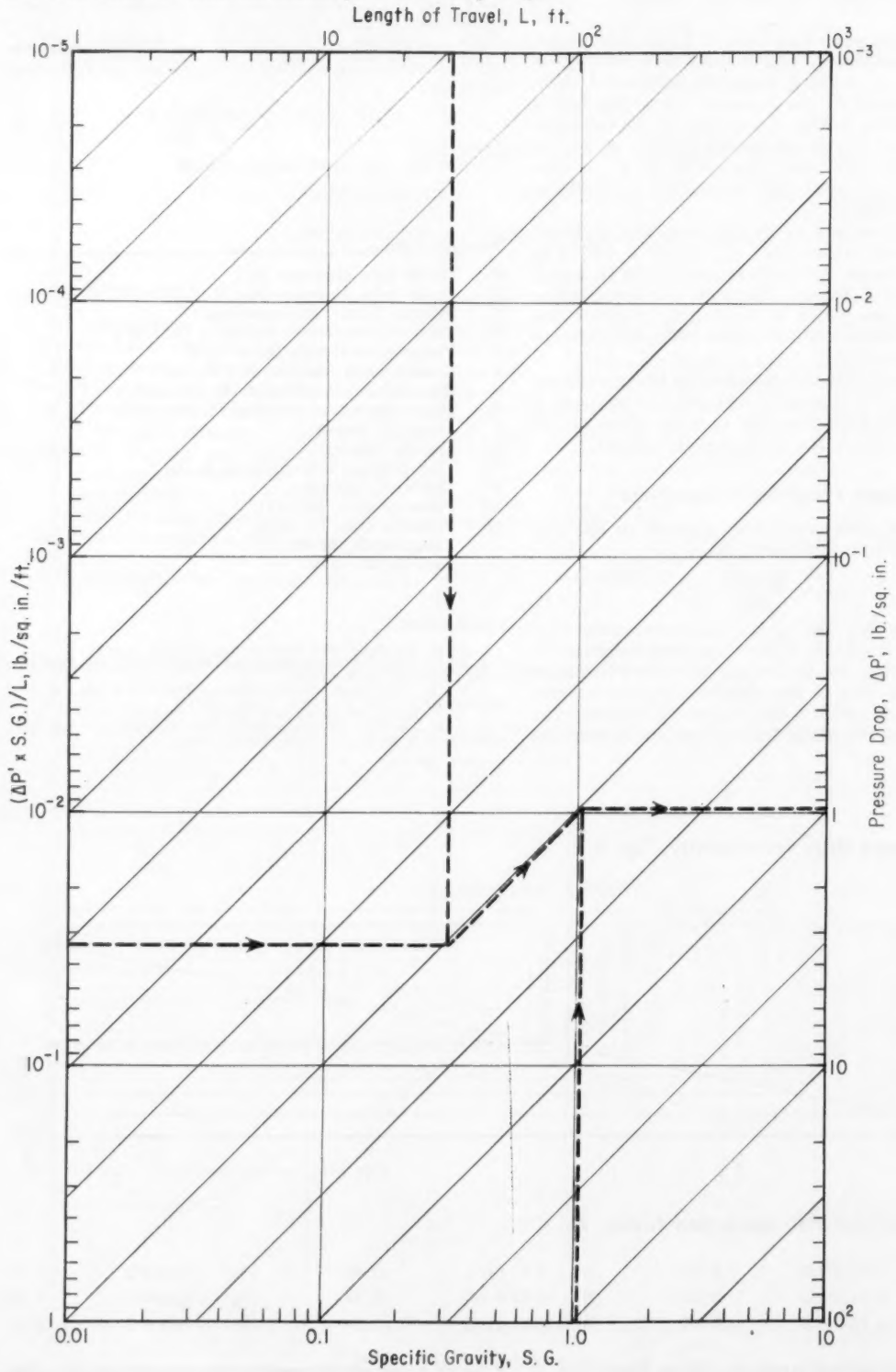


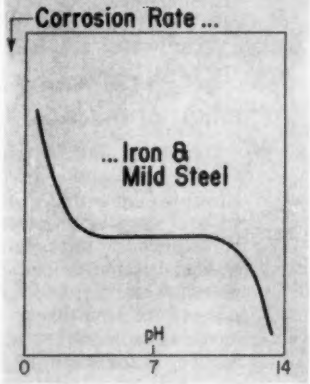
And then use tube size correction factor, $F_{D'}$

⅜″ × 16 BWG	2.95	1″ × 10 BWG	0.46	1¼″ × 10 BWG	0.11
¾″ × 14 BWG	1.34	1″ × 12 BWG	0.34	1¼″ × 12 BWG	0.09
¾″ × 16 BWG	1.00	1″ × 14 BWG	0.24	1¼″ × 14 BWG	0.07

Finally find required pressure drop from Fig. 3 on next page →

Use this chart to find corrected pressure drop, Fig. 3





How Environment Directs Corrosion Control

- Effect of pH governs spontaneity of corrosion reactions
- Oxidizing agents may accelerate corrosion rates
- High liquid velocities erode protective films
- Temperature determines intensity of corrosion attack
- Inhibitors offer control of corrosion rates and areas

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In approaching any corrosion problem, always consider environment modification first. By this means simple, inexpensive solutions are often found without need for extensive modification or rebuilding of equipment. The relative importance of environmental factors varies from one system to another. Usually the ones most significant to corrosion control are pH, oxidizing agent content, temperature and velocity of the corroding medium.

Often we are not free to adjust these variables in a way to achieve optimum corrosion control. This is especially true in the chemical industry where conditions in corrosive media are usually set within rather narrow limits by process requirements. In some such cases it is possible to retard corrosion by adding small amounts of inhibitors which serve to promote polarization. Though not always applicable, cathodic protection provides electrical inhibition in situations where chemical inhibitors are not practical or permissable.

How pH Affects Corrosion

Since either hydrogen or hydroxyl ions are involved in most common corrosion cell reactions, we can expect pH to be an important variable in corrosive media. As a general rule, we know that acid solutions are more corrosive than neutral or alkaline solutions. The effect of pH on the spontaneity of corrosion reactions in both hydrogen-type and oxygen-type corrosion is to decrease corrosion linearly as pH increases.

Thus the driving force for simple corrosion reactions is materially less in alkaline solutions than in acid media. Exceptions to this generalization occur with aluminum, lead, zinc and other amphoteric metals which are capable of forming complex ions at high pH. These exceptions introduce new anode reactions and increase cell driving force under strongly alkaline conditions. Such metals are most resistant to corrosion in the middle or neutral pH range.

The actual rate at which a given metal corrodes at a particular pH level depends on various factors which serve to establish resisting or polarizing effects. These include oxygen concentration, protective films, hydrogen overvoltage and metal-ion concentration. Speller[1] discusses the interdependence of the variables involved and Uhlig[2] summarizes and interprets experimental data on pH effects in the corrosion of various metals.

With iron and mild steel, a relation between corrosion rate and pH similar to Fig. 1 is usually observed. At pH values below 4,

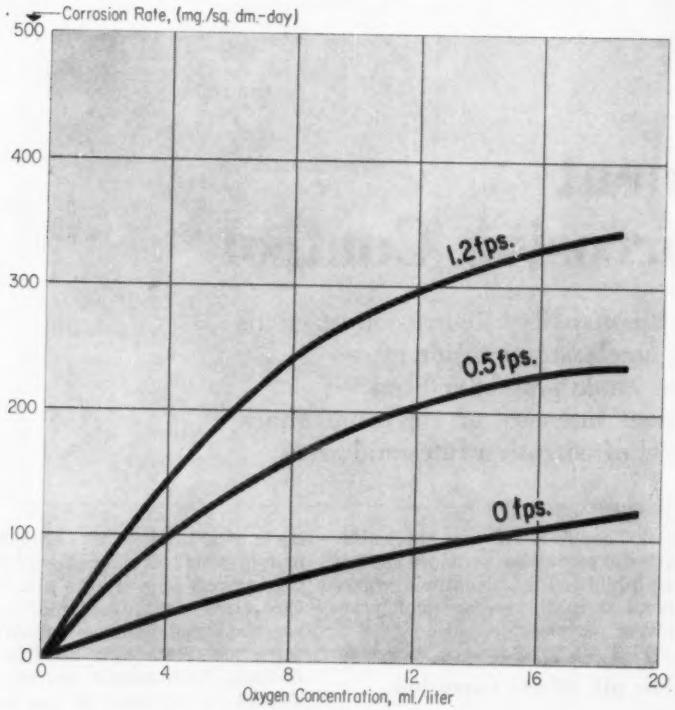
* To meet your author, see *Chem. Eng.*, July 28, 1958, p. 161.

How Oxygen Affects Corrosion Rate of Metals, Table I

Metal	Acid	Corrosion Rate, mdd. No Oxygen	Saturated With Oxygen
Mild steel	6% H_2SO_4	168	1,956
Lead	4% HCl	134	1,276
Copper	4% HCl	105	8,580
Tin	6% H_2SO_4	35	4,391
Nickel	4% HCl	37	2,715
Monel	2% H_2SO_4	6	571
Stainless steel 18Cr-8Ni	5% H_2SO_4	300	2 (with air)

Corrosion rate at atmospheric temperature, mg./sq.dm.-day.

Oxygen and velocity control corrosion of steel in water, Fig. 2



hydrogen evolution is the dominant reaction and corrosion rate is governed by surface conditions which determine hydrogen overvoltage. In the neutral zone, between pH values from 4 to 9.5, corrosion proceeds at a constant rate. We determine corrosion rate by the rate of diffusion of oxygen to the metal through a protective layer of ferrous hydroxide which maintains the metal surface at substantially pH equal to 9.5.

Further increase in alkalinity reduces corrosion rate by decreasing the rate of the surface reaction and lowering the permeability of the corrosion product layer to oxygen. Agitating the medium or increasing its temperature accelerates oxygen diffusion, widening the neutral zone and raising corrosion rate. Agitation also reduces hydrogen overvoltage, leading to higher corrosion rate in the acid zone.

Usually optimum enviromental conditions for corrosion control can not be attained by pH adjustment alone, nor can the desirable adjustments always be made. However, proper regard for pH effects is an important step in solving many corrosion problems. Thus pH is a major specification in the treatment of boiler-feed waters. Maintenance of slightly alkaline conditions in cooling water systems is common practice.

Effects of Oxidizing Agents

Oxidizing agents may influence metalic corrosion in two ways. First, we know that the presence of an oxidizing agent, capable of being reduced at cathode areas, is an essential requirement for electrochemical corrosion. Thus we can expect corrosion rate to vary almost in direct proportion to the concentration of oxidizing agent in the environment. However, we also know that some metals—notably aluminum, titanium and stainless steels—become passive by the formation of protective surface layers of oxide. Such metals are more resistant in oxidizing than in non-oxidizing environments.

May[3] cites several examples giving experimental verification of oxidizing agent effects. Note that corrosion rate of most metals as shown in Fig. 2 increases sharply with oxygen content of the medium. The contrast in behavior between stainless steel which readily forms a protective film in air and the other metals which do not is evident in Table I.

Dissolved oxygen causes serious corrosion problems in closed water systems particularly when cold raw water containing a fresh supply of oxygen replaces withdrawn hot water or steam. In hot water supply systems, 0.1 ppm. of free oxygen is permissable. In high-pressure boilers, oxygen concentration[5] should be kept below 0.005 ppm.

Various mechanical and chemical means for removal of dissolved oxygen are standard practice.[4, 5, 6] Mechanical methods include open, vacuum and spray-type deaerators; and apparatus for passing water over a large surface of activated iron. Chemical methods depend on the addition of reducing agents such as sodium sulfite or hydrazine to react with traces of oxygen.

In the chemical industry, dissolved oxygen is only one of many oxidizing agents. Others include chlorine, fluorine and a variety of ions which are effective oxidizers. Data by May[3] show that the cor-

rosion rate of Monel in dilute sulfuric acid is increased nearly ten-fold by the addition of 0.18% ferric sulfate to the solution.

Careful consideration is often required to identify the oxidizing agent in a given chemical system. Process requirements may prevent its elimination but proper attention to this environmental factor can be helpful in corrosion problems.

Consider Temperature Effects

Temperature effects in corrosion processes are complex because both physical and chemical steps are involved. Each of these steps may be influenced by temperature in a different way. As a general rule, we know that chemical reaction rates increase with increasing temperature. This is also true of the chemical steps in corrosion.

However, we also know that gas solubility in liquids decreases as temperature increases. This decreased solubility reduces corrosion rate where oxygen or other oxidizing gases participate in the reactions but increases the rate where hydrogen is evolved. We must also consider the effects of temperature on protective films and on corrosion product deposits. Thus the over-all response of any given system to temperature changes is rather difficult to predict without some specific knowledge of the corrosion mechanism.

For example: the corrosion of iron and mild steel in the presence of air is controlled by oxygen diffusion over a fairly wide range of pH. Thus in systems open to the atmosphere, we can expect corrosion rate to increase initially with temperature as chemical reaction rates are accelerated. However, when oxygen solubility becomes too low to support corrosion, we can anticipate a sharp decrease in rate. This effect has been demonstrated experimentally with maximum rate occuring at about 175 F.

A similar effect has been found in the corrosion of Monel in dilute sulfuric acid where the rate at 212 F. is only half the value at 68 F. and less than one-seventh the maximum rate found again at 175 F. In closed systems from which oxygen cannot escape, corrosion rate of iron and mild steel approximately doubles[7] with every 55 F. degree increase in temperature.

Contrasting effects[8] of temperature on two types of protective films are shown in Fig. 3. The film formed on stainless steel in strongly oxidizing medium is relatively stable and corrosion rate is low over a wide range of temperatures. Data for zinc in Fig. 3 show that a protective film of corrosion products prevents serious corrosion up to about 50 C. Between 50 C. and 60 C., the film is converted to a non-protective form permitting very rapid attack and leading to a maximum rate at about 65 C. At higher temperatures, corrosion rate decreases because of decreasing oxygen solubility.

Sometimes we encounter situations in which insoluble deposits are precipated from corrosive media, either as scale or as part of the chemical reactions in process equipment. Such deposits are not likely to be uniform in all parts of the equipment or to be protective. They often promote concentration cell corrosion and localized attack, particularly on heat-transfer surfaces.

Most precipitates increase in solubility as temperature increases. A few, notably calcium sulfate, show the reverse effect and are especially troublesome.

Velocity Effects Are Important

Chemical engineers are familiar with stream velocity effects in mass transfer operations. The same principles apply to corrosion in flowing media. Increasing velocity usually increases corrosion rate by reducing surface film resistances and sweeping away corrosion products. Curves such as Fig. 2 are typical of many systems in which corrosion rate increases with velocity until a level is reached beyond which oxygen availability at the metal surface is no longer controlled by diffusion.

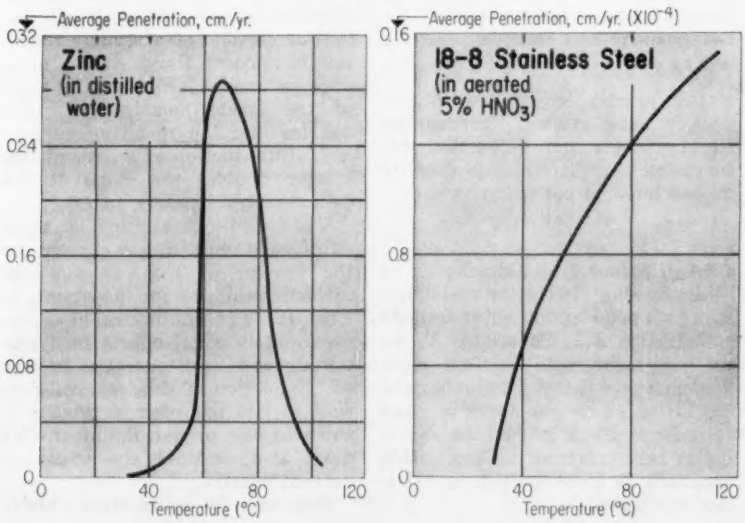
In this case, reaction rate at the cathode sites becomes the dominant factor.

In some special cases, as with cupronickel in sea water,[9] critical velocities are found beyond which protective films are destroyed and corrosion is accelerated. In others, where some component of a solution can passivate the metal raising velocity may result in lower corrosion rates.[8]

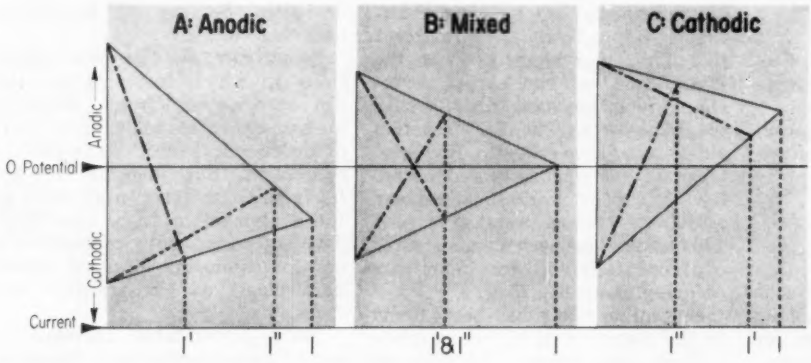
Under conditions of highly turbulent flow, cavities may form in the liquid which collapse on the metal surface. The result is a type of combined mechanical and chemical attack called cavitation erosion. As gas or vapor cavities move along a metal surface, their rapid collapse causes high speed liquid-metal impact, work-hardening and roughening the surface.

Such mechanical damage, accompanied by chemical corrosion, results in severe attack[8] in these areas. Sharp-edged pits characterize this type of atack and are found

Compare temperature effects for these systems. Fig. 3



Inhibitors give corrosion control by changing cell polarization currents, Fig. 4



in low-pressure areas in propellers, pumps and valves. Erosion problems are magnified when the flowing fluid contains suspended solids.

Thus velocity is an important environmental factor to consider, especially in chemical plants, where fluids of all kinds are handled. Sometimes we encounter major problems which require complete redesign of equipment. However, the alert plant engineer can make minor piping changes readily to solve corrosion problems.

Other Significant Factors

We shall mention briefly a few other significant environmental factors. Dissolved salts[1] generally accelerate corrosion by increasing the conductivity of the corroding medium. Some may enter directly into the corrosion reactions acting as accelerators or as inhibitors. Chloride ion accelerates corrosion of aluminum and stainless steel by attacking passivating oxide films.

Biological influences are important in a number of systems. Microscopic organisms such as barnacles cause electrolytic concentration cells leading to accelerated local corrosion on ships and marine structures. The metabolic functions of bacteria and other microbiological organisms can affect corrosion reactions directly by metal or oxygen consumption, particularly in stagnant water or soil environments. Details of these effects are beyond our present discussion. For more information, see Speller[1] and Uhlig.[2]

Light can cause small potential differences between illuminated and non-illuminated areas of metals. Bannister and Rigby[10] demonstrated experimentally that illuminated areas of several metals were up to 0.1 volt more cathodic than darkened areas. Ultraviolet light has been shown to accelerate corrosion of polished steel.[11] In addition, prolonged exposure to light deteriorates paint and other protective coatings. Thus the corrosion engineer can not afford to ignore light as an environmental factor.

How Inhibitors Stem Corrosion

To understand better the functions of inhibitors, we shall extend the discussion of cell polarization begun in *Chem. Eng.*, Aug. 25, 1958, p. 125. Our discussion follows the treatment proposed by Mears.[12] We have stated that the limiting rate in a corroding system is established when the total polarization potential E_T' equals the total cell driving force or open-circuit potential between anode and cathode area, E_o.

$$E_T' = E_a' + E_c' + I\,(R_e + R_i) = E_o \qquad (1)$$

Metal circuit resistance R_e is usually negligible. Rearranging Eq. (1) yields and expression for corrosion current which is directly proportional to corrosion rate.

$$I = \frac{E_o - (E_a' + E_c')}{R_i} \qquad (2)$$

We can reduce I by reducing E_o or by increasing electrolyte resistance R_i, anode polarization E_a' or cathode polarization E_c'. To reduce E_o we can make the metal surface more homogeneous thereby reducing the inequities between anodic and cathodic areas or by surface polishing or heat treatment. Usually this approach is inconvenient in existing equipment.

Although some inhibitors function by reducing E_o, the usual approach is to add substances which serve to increase E_a' or E_c' or both. This is accomplished at the electrode sites by establishing concentration polarization, by creating or enhancing surface films, by promoting overvoltage or by a combination of these effects.

Cell potential relationships are shown in Fig. 4 in a simplified form which is convenient for inhibitor considerations. Here we assume that electrolyte resistance is small and that electrode potentials vary linearly with current. Corroding systems may be under anodic control, cathodic control or mixed control. The relative polarizability of the respective electrode areas determines the type of control.

Assume we have available for use in each system a cathodic inhibitor capable of polarizing half of the effective cathodes or an anodic inhibitor capable of a similar reduction in anode activity. If we introduce an anodic inhibitor, the slope of the anode polarization curve doubles and the resulting current is I'. Introduction of a cathodic inhibitor doubles the slope of the cathode curve leading to I''.

The anodic inhibitor is more effective in reducing cell current for the system in Fig. 4*a* and the cathodic inhibitor for the system in Fig. 4*c*. The inhibitors have approximately equal effects in a system under mixed control as in Fig. 4*b*. Reduction of the total cell current is not the main criterion in choosing the proper inhibitor. We must also consider the effect on current density.

Suppose in a system under

cathodic control, we use an anodic inhibitor thus reducing anode area markedly but cell current only slightly. This condition actually accelerates corrosion since current density at the remaining anode areas increases substantially. Thus, when improperly used anodic inhibitors can be dangerous.

On the other hand, cathodic inhibitors are always safe. They are essentially ineffective in systems under anodic control. Since they do not reduce anodic area, increased intensity of attack can not result.

Inhibitors are not cure-alls. We must understand the symptoms of our corroding system and match these with known characteristics of the inhibitors we prescribe. Gatos[18] points out that much of our knowledge of inhibitors is still based on empirical testing. Many different chemicals, both organic and inorganic, are effective and these have been classified in various ways in the literature. Some typical inhibitors and the systems in which they are used commercially are given in Table II.

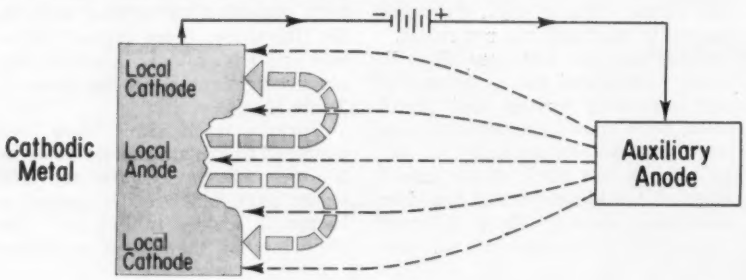
Various mechanisms have been proposed to explain the action of inhibitors. Some controversy still exists particularly with respect to inorganic anodic inhibitors.[18] One view is that they form protective

Typical Commercial Corrosion Inhibitors, Table II

Inorganic Inhibitors	Approximate Conc., %	Corrosion Environment	Metallic System
Borax	2–3	Alcohol antifreeze mixtures	Automobile cooling system
Calgon	Small Amount	Water systems	Steel
Disodium hydrogen phosphate	0.5	Citric acid	Steel
Potassium dichromate	0.05–0.2	Tap water 68–194 F.	Iron-brass
Potassium dihydrogen phosphate + sodium nitrite	Small Amount + 5%	Sea Water	Steel
Potassium permanganate	0.10	0.3N NaOH solution	Aluminum
Sodium benzoate	0.5	0.03% NaCl solution	Mild steel
Sodium carbonate	Small Amount	Gas condensate wells	Iron
Sodium chromate	>0.5	Cooling water	Electrical rectifier systems
Sodium chromate	0.07	$CaCl_2$ brine	Cu, brass
Sodium dichromate	0.025	Water	Air-conditioning equipment
Sodium dichromate + sodium nitrate	0.1 + 0.05	Water	Heat-exchange devices
Sodium hexametaphosphate	0.002	Water, about pH = 6	Lead
Sodium metaphosphate	Small Amount	Ammonia	Mild steel condensers
Sodium nitrite	0.005	Water	Mild steel
Sodium nitrite	20% of sea water	Sea water-distilled water mixtures	Mild steel
Sodium orthophosphate	1	Water pH = 7.25	Iron
Sodium silicate	Small Amount	Sea water	Zn, Zn-Al alloys
Sodium silicate	0.01	Oil-field brines	Steel pipes
Organic Inhibitors			
Benzanilide	0.2	Lubricants	Cd-Ni, Cu-Pb bearings
Formaldehyde	Small Amount	Oil wells	Oil-well equipment
Formaldehyde	0.05	Sour crude oil	Diesel engines
Dioctyl ester of sulfosuccinic acid	0.05	Refined petroleum oils	Pipe lines
Erythritol	Small Amount	K_2SO_4 solution	Mild steel
Ethylaniline	0.5	HCl solutions	Ferrous metals
Mercaptobenzothiazole	1	HCl solutions	Iron and steel
Morpholine	0.2	Water	Heat-exchange systems
Oleic acid	Small Amount	Polyhydric alcohols	Iron
Phenyl acridine	0.5	H_2SO_4 solutions	Iron
Pyridine + phenylhydrazine	0.5 + 0.5	HCl solutions	Ferrous metals
Quinoline ethiodide	0.1	1N H_2SO_4	Steel
Rosin amine-ethylene oxide	0.2	HCl solutions	Mild steel
Tetramethylammonium azide	0.5	Aqueous solutions of organic solvents	Iron and steel
Thiourea	1	Acids	Iron and steel

Table from *Corrosion*, Jan. 1956, pp. 23t-32t.

Auxiliary anode provides cathodic protection, Fig. 5



insoluble films on metals surfaces. Another states that they merely adsorb without forming definite compounds.

Strong evidence for the oxide-film theory derives from tests[14,15] with nitrites, chromates, phosphates and molybdates in aerated solutions. However, potential measurement studies[16] with chromate, molybdates and tungstates support the adsorption hypotheses.

Salts of zinc, nickel, manganese and chromium are the principal inorganic cathodic inhibitors. These salts function by forming insoluble hydroxides which impede oxygen and hydrogen ion reduction at cathode areas. Organic inhibitors are usually polar molecules containing nitrogen (amines, pyridines, quinolines), oxygen (aldehydes, ketones, acids) or sulfur (mercaptans). These compounds adsorb primarily at cathodic areas[18] and increase overvoltage.

Also a number of high molecular weight organic substances such as gelatin, glue, egg albumin and dextrine function as general inhibitors[17] to both anodic and cathodic areas. These form a porous layer which increases corrosion cell resistance.

In the final analysis, selecting the proper inhibitor for a particular corroding system becomes a process trial and error. However, reference to critical reviews of the literature[18] and the general principles we have discussed provides a logical starting point for a testing program.

Apply Cathodic Protection

Cathodic protection is a method of electrical inhibition whereby a direct current is applied to the protected surface. Hence, the protected surface becomes cathodic as illustrated in Fig. 5. Complete protection occurs when the anode currents reach zero. Pearson[18] discusses in detail the various current relationships and the criteria for protection in systems under anodic, cathodic and mixed control.

Cathodic protection is widely used in controlling corrosion in marine structures, tanks, water circulating systems and underground pipelines. It is not applicable to surfaces that are continuously in the atmosphere or in non-conducting liquids.

Current for the protection circuit may be generated by means of sacrificial galvanic anodes or impressed through relatively permanent anodes via a battery or small rectifier. Zinc, magnesium, aluminum and their alloys are commonly used as sacrificial anodes. Steel, graphite, cast iron and platinum are permanent anodes for impressed current.[5] Galvanizing and cadmium plating are forms of cathodic protection.

In applying cathodic protection, it is necessary to determine the current requirements established by the properties of the surface to be protected and environmental conditions. Approximate protective currents are shown in Table III for steel in various environments.

As a general rule-of-thumb, May[3] suggests that a shift of 150 to 200 millivolts in surface potential is required for safe protection; or that the surface be maintained below 0.85 volt anodic to a saturated calomel reference electrode.

Various schemes for applying cathodic protection in different situations are reported regularly in the literature.[19,20] Selection of the best method for any given application depends on relative costs of materials, installation and maintenance.

Order of Magnitude of Protective Currents for Steel, Table III

Environment	Amp./Sq. Cm.
Well-cured halogen-free concrete	7×10^{-8}
Sterile, anerobic neutral soil water	5×10^{-7}
Halogen-containing concrete	5×10^{-7}
Aerated neutral soil water	4×10^{-6}
Deaerated hot water	4×10^{-6}
Moving fresh water	6×10^{-6}
Moving sea water	1.5×10^{-5}
Oxygen-saturated hot water	1.5×10^{-5}
Anaerobic soil with active sulfate reducing bacteria	5×10^{-5}
Hot sulfuric acid	4×10^{-2}

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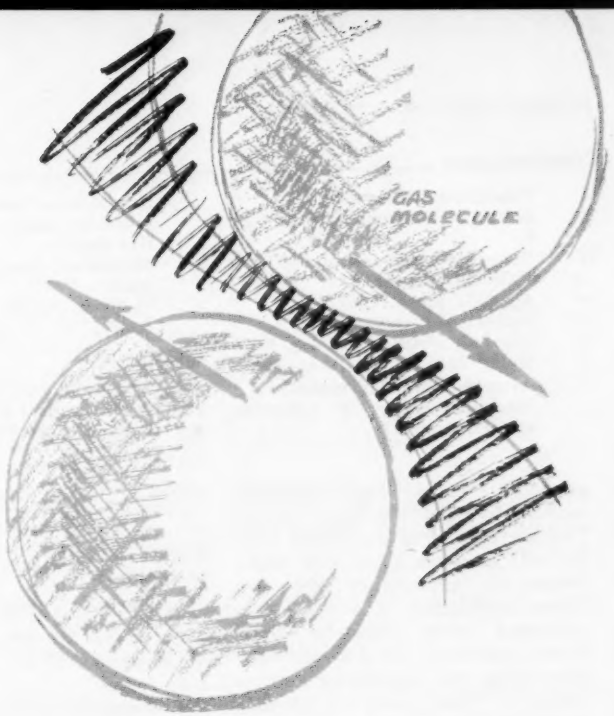
How to Estimate
Engineering Properties



In this issue your author begins a new major section of this award-winning series.

Estimate Low-Pressure Gas Viscosity

Wallace R. Gambill, Union Carbide Nuclear Co., Oak Ridge, Tenn. *

In many chemical engineering applications of heat, mass and momentum transfer, the exponent on the viscosity term is quite small, thus reducing the degree of accuracy required of a viscosity prediction to be used in engineering calculations.

The critical examination and ranking of today's methods for estimating viscosity is the main intent of these next few articles. We plan to cover the viscosity of gases and gas mixtures; and viscosity of Newtonian liquids and liquid mixtures.

Considerable experimental difficulties are associated with the determination of highly accurate gas viscosities, especially at elevated temperatures and pressures. Some of the relations discussed here permit the calculation of gas viscosity within the experimental error of many experimental data, or within the percentage of discordance between the values of various investigators for the same gas.

The situation may be summarized this way: The viscosities of most gases and vapors at low pressure may be predicted with excellent accuracy at any temperaure now used in the chemical process industries; as may the viscosities of low-pressure gaseous mixtures. The uncertainty of pressure-dependence prediction is larger, but generally not too large for engineering usefulness.

When You Have No Data

First let's consider methods that can be used for the direct calculation of low-pressure gas viscosity when no viscosity data are available.

For absolute pressures from a few mm. of Hg to several atm., gas viscosity is affected only very slightly by pressure, as predicted by simple kinetic theory. From classical kinetic theory, [1,2] the relation for gas viscosity is:

$$\mu_g^\circ = \rho V_m L/2 \qquad (1)$$

where ρ is in grams/cc.; V_m = cm./sec.; L = cm.; and μ = cp.

Substitution of other kinetic-theory relations (for density, mean free path and molecular velocity) into Eq. (1), gives us:

$$\mu_g^\circ = 27.2\,(MT)^{0.5}/\sigma^2 \qquad (2)$$

where μ = micropoises; T is in deg. K.; and σ is molecular diameter in Angstrom units.

Eqs. (1) and (2) apply only approximately even for the simplest, nonpolar real gases. The methods discussed below have resulted from more extended treatments and are more accurate as well as more convenient for technical use. Gas viscosity actually increases more rapidly with temperature than as the square root, which is one of the weaknesses of this early theoretical derivation. In the past, Eq. (2) was usually used to calculate the molecular diameter from μ_g data.

For pure, nonpolar, symmetrical gases the viscosity equation developed by Hirschfelder and coworkers [3, 4] may be written as:

$$\mu_g^\circ = 26.69\,(MT)^{0.5}/\sigma^2\phi_V \qquad (3)$$

The viscosity function, ϕ_V, similar to the diffusion function, ϕ_D (see *Chem. Eng.*, June 2, 1958, p. 127), is a function of kT/ϵ. We have listed some selected values in Table I.

Though derived for monatomic gases, Eq. (3) is also applicable to polyatomic gases since μ is relatively unaffected by internal de-

* To meet your author see *Chem. Eng.*, Feb. 10, 1958, p. 173.

Nomenclature

f	Functional dependence.
k	Boltzmann's constant, ergs/deg. K.
L	Molecular mean free path.
M	Molecular weight.
P	Absolute pressure, atm.
S	Sutherland's constant.
T	Absolute temperature, deg. K.
V	Molar gas vol., cc./gram-mole.
V_m	Average molecular velocity.
ϵ	Maximum energy of molecular attraction, ergs.
μ_g°	Low-pressure gas viscosity, micropoises, except Eq. (1).
ρ	Gas density.
σ	Molecular diameter, Angstrom units.
ϕ_V	Collision function for gas viscosity.

Subscripts

b	At normal boiling point.
c	At the critical point.
r	Reduced property.

grees of freedom. Higher approximations to Eq. (3) differ by <1%. The average error associated with Eq. (3) is about 2-3% over broad ranges of temperature when the "force constants" σ and ϵ/k are evaluated from viscosity data. Force constants for a dozen common gases are reproduced here as Table II.[4] When σ and ϵ/k are estimated empirically, the accuracy decreases somewhat (see discussion below).

Bromley and Wilke,[5] in their excellent review of gas viscosity calculation, recast Eq. (3) into this form:

$$\mu_g^\circ = 26.7\left[\frac{(M\epsilon/k)^{0.5}}{\sigma^2}\right]\left[f(kT/\epsilon)\right] \quad (4)$$

where,

$$f(kT/\epsilon) = (kT/\epsilon)^{0.5}/\phi_V$$

For $10 < (kT/\epsilon) < 400$, it is proposed that:

$$f(kT/\epsilon) = 0.878\,(kT/\epsilon)^{0.645} \quad (5)$$

For $(kT/\epsilon) < 10$, Bromley and Wilke gave $f(kT/\epsilon)$ in lengthy tabular form.

Combination of Eq. (4) with the following empirical estimation equations for the force constants;

$$\epsilon/k = 0.75\,T_c \quad (6)$$

$$\sigma = 0.833\,V_c^{0.333} \quad (7)$$

yields the final equation for low-pressure gas viscosity:

$$\mu_g^\circ = \frac{33.3\,(MT_c)^{0.5}}{V_c^{0.667}}\left[f(kT/\epsilon)\right] \quad (8)$$

Values of Collision Function for Viscosity—Table I

kT/ϵ	ϕ_V	kT/ϵ	ϕ_V	kT/ϵ	ϕ_V	kT/ϵ	ϕ_V
0.30	2.785	1.35	1.375	2.70	1.069	4.70	0.9382
0.35	2.628	1.40	1.353	2.80	1.058	4.80	0.9343
0.40	2.492	1.45	1.333	2.90	1.048	4.90	0.9305
0.45	2.368	1.50	1.314	3.00	1.039	5.0	0.9269
0.50	2.257	1.55	1.296	3.10	1.030	6.0	0.8963
0.55	2.156	1.60	1.279	3.20	1.022	7.0	0.8727
0.60	2.065	1.65	1.264	3.30	1.014	8.0	0.8538
0.65	1.982	1.70	1.248	3.40	1.007	9.0	0.8379
0.70	1.908	1.75	1.234	3.50	0.9999	10	0.8242
0.75	1.841	1.80	1.221	3.60	0.9932	20	0.7432
0.80	1.780	1.85	1.209	3.70	0.9870	30	0.7005
0.85	1.725	1.90	1.197	3.80	0.9811	40	0.6718
0.90	1.675	1.95	1.186	3.90	0.9755	50	0.6504
0.95	1.629	2.00	1.175	4.00	0.9700	60	0.6335
1.00	1.587	2.10	1.156	4.10	0.9649	70	0.6194
1.05	1.549	2.20	1.138	4.20	0.9600	80	0.6076
1.10	1.514	2.30	1.122	4.30	0.9553	90	0.5973
1.15	1.482	2.40	1.107	4.40	0.9507	100	0.5882
1.20	1.452	2.50	1.093	4.50	0.9464	200	0.5320
1.25	1.424	2.60	1.081	4.60	0.9422	300	0.5016
1.30	1.399					400	0.4811

Source—Hirschfelder, J. O., R. B. Bird and E. L. Spotz, Trans. ASME, Nov. 1949, p. 925.

Force Constants from Viscosity, Selected Gases—Table II

	σ, In Angstroms	ϵ/k, Deg. K.		σ, In Angstroms	ϵ/k, Deg. K.
Air	3.617	97.0	SO_2	4.290	252
N_2	3.681	91.5	F_2	3.653	112
O_2	3.433	113	Cl_2	4.115	357
CO	3.590	110	HCl	3.305	360
CO_2	3.996	190	C_6H_6	5.270	440
CH_4	3.882	137	C_2H_5OH	4.455	391

For 45 gases and vapors at about room temperature (including alcohols, hydrocarbons, steam, esters, but excluding H_2 and He) for which the critical constants were known, the avg. error associated with Eq. (8) was 4.4%. For a few highly polar gases, the max. error was about 15%. Use of estimated values for T_c and V_c would probably increase the avg. error to about 8%.

For cases where V_c is unknown and difficult to estimate accurately, Bromley and Wilke[5] suggested the following alternate relation, based on an equation of Licht and Stechert:[6]

$$\mu_g^\circ = \frac{4.23\,M^{0.5}P_c^{0.667}}{T_c^{0.167}}\left[f(kT/\epsilon)\right] \quad (9)$$

For 58 gases and vapors for which T_c and P_c were known, the avg. deviation of Eq. (9) was 4.6%, or nearly the same as that of Eq. (8). Use of estimated T_c and P_c would probably increase the avg. error to about 9%.

The lengthy table given by Bromley and Wilke,[5] relating $f(kT/\epsilon)$ to (kT/ϵ) was reduced to a relatively simple equation by Scheibel:[7]

$$f(kT/\epsilon) = 0.879(kT/\epsilon)^{0.645} - 0.261\,b^{-0.9\log b} \quad (10)$$

where $b = [(kT/\epsilon)/0.7]$

This checks the tabular values within 1% or less for $0.4 < (kT/\epsilon) < 400$. Eq. (10) may, of course, be used in Eqs. (4), (8) and (9).

By combining Eq. (6) for (ϵ/k) with Eq. (10), one obtains a relation in terms of the more familiar reduced temperature:

$$f(kT/\epsilon) = 1.058\,T_r^{0.645} - (0.261/1.9\,T_r^{0.9\log b}) \quad (11)$$

where $b = 1.9\,T_r$,

which is applicable for $T_r > 0.3$. Combination of Eq. (8) with Eq. (11) gives Scheibel's proposal:

$$\mu_g^\circ = \frac{(MT_c)^{0.5}}{V_c^{0.667}} \times 35.2T_r^{0.645} - [8.7/(1.9T_r)^{0.9\log(1.9T_r)}] \quad (12)$$

which should exhibit an accuracy identical to that of Eq. (8).

The writer has derived a relation very similar to Eq. (12), but based on different estimation equations for the force constants, σ and ϵ/k. It has been shown in estimating gas-phase diffusion coefficients that the following equations give somewhat more accurate results than Eqs. (6) and (7):[8]

$$\epsilon/k = 1.21\,T_b \quad (13)$$

$$\sigma = 1.18\,V_b^{0.333} \quad (14)$$

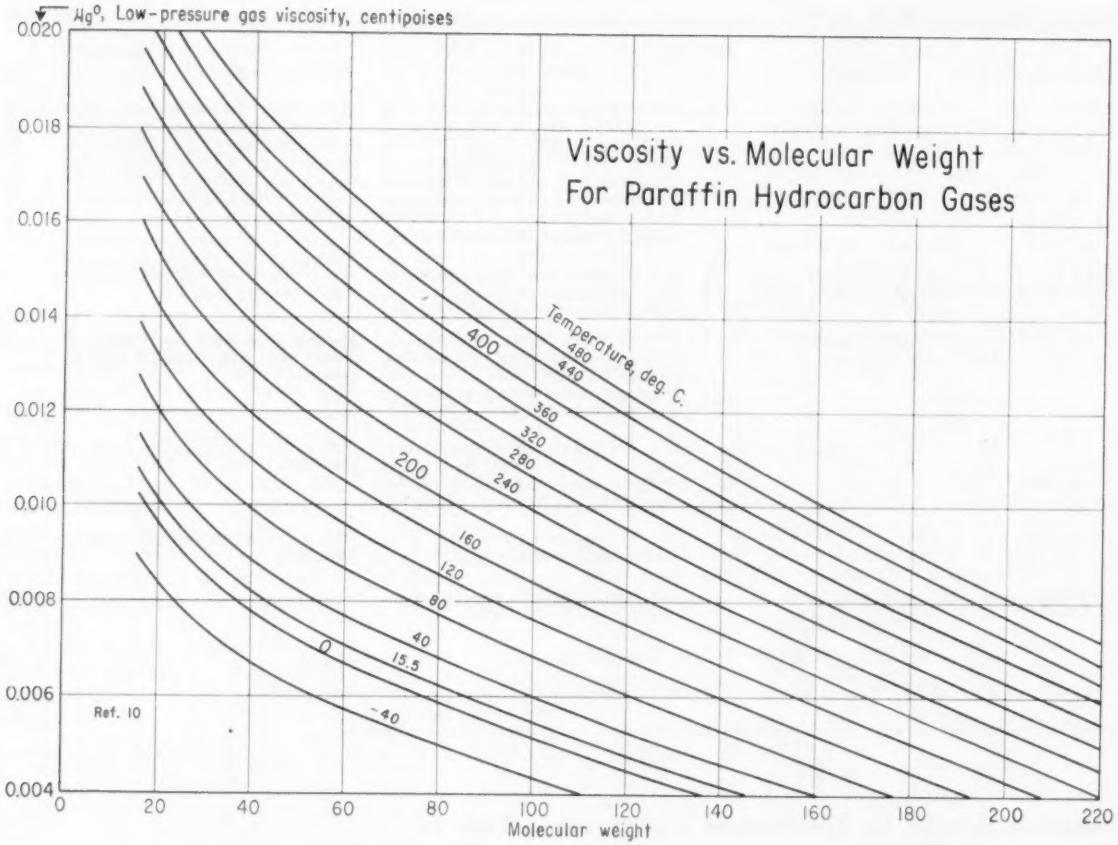
Direct Calculation Methods, Low-Pressure Gas Viscosity—Table III

Proponent	Correlation	Accuracy	Notes	Ref.
Arnold	$\mu_g^\circ = \frac{27.0\,M^{0.5}T^{1.5}}{V_b^{0.667}(T + 1.47T_b)}$	For 39 points on 22 gases from −73 to 1,000 C., avg. & max. errors of 5.2% and 14.9%. Only HCl was above 10%. Comparison based on data in Refs. 13, 14 and 15, includes 15 nonpolar or slightly polar gases and 7 highly polar. V_b was calculated from additive contributions.	Derived on the assumption that molecular diameter is proportional to the cube root of V_b. Sutherland constant, S, approximated from Vogel's rule, Ref. 16: $S \cong 1.47\,T_b$	11, 12
Licht & Stechert	$\mu_g^\circ = \frac{6.30\,M^{0.5}P_c^{0.667}}{T_c^{0.167}}\left(\frac{T_r^{1.5}}{T_r + 0.8}\right)$	For 26 gases, avg. error was about 5%, and in some cases less than 2%. Agreement not good for H_2 and He.	The result of an extensive survey of gas-viscosity behavior.	17
	$\mu_{Tc}^\circ = \frac{3.50\,M^{0.5}P_c^{0.667}}{T_c^{0.167}}$	For 23 gases, max. error = 21%, with poorest agreement for ethanol, steam, NH_3 and He. These four gases not included in evaluation of avg. constant of 3.50.	A study of 56 gases by Bromley & Wilke[5] gave avg. constant of 3.53 instead of 3.50.	17
Johnson, Huang & Kemp	$\mu_g^\circ = \frac{4.53\,M^{0.5}P_c^{0.667}T^{0.782}}{T_c}$	For 131 points on 31 gases, avg. dev. = 5.1% and max. error about 33%. Agreement not good for steam, H_2, He, Br_2, Ne, or CH_3OH.	Data covered temperature range of 175–1,400 K.	18
Falkovskii	$\mu_g^\circ = 1.286\,M^{0.5}P_c^{0.667}T_r$	For 22 organic vapors, avg. error was reportedly about 5%.	Data covered temperature range of 273–973 K.	19
Grunberg & Nissan	$\mu_g^\circ = \frac{51.7\,T^{0.5}\rho_c^{0.667}}{M^{0.167}\exp[1/(2T_r)]}$	For 8 gases at 0 C., avg. and max. errors = 7.7% and 15.2%.	———	20
	$\mu_{Tc}^\circ = 31.4T_c^{0.5}\rho_c^{0.667}/M^{0.167}$	———	———	20
	$\mu_c \cong 61T_c^{0.5}\rho_c^{0.667}/M^{0.167}$	———	———	20

Note—Units throughout are: micropoises, deg. K., atm. abs., cc./gram-mole and grams/cc.

Graphical Methods for Low-Pressure Gas Viscosity—Table IV

Proponent	Correlation	Accuracy	Notes	Ref.
LeFevre	A plot of log T_r vs. log of $T_r^{0.5}(P_c^2T_c^3\rho_c^3)^{0.167}/\mu_g^\circ$	For 15 gases, about 5% avg. error. No good for H_2, He, Hg and NO.	Use any consistent set of units.	21
Whalley	A plot of $\left[\frac{\mu_g^\circ V_c^{0.667}}{(MT)^{0.5}}\right]$ vs. T_r.	For 8 nonpolar gases, deviations are small. Agreement not good for H_2, He, and Ne. CO correlates high.	The bracketed group is a type of reduced viscosity. For nonpolar gases. T_r chart range of 0.4 to about 13.5.	22
Smith & Brown	A plot of $(\mu_g/M^{0.5})$ vs. T_r and P_r for the normal paraffins, excluding methane.	Claimed to equal that of experimental data (2–5%).	A plot of log $(\mu_g^\circ/M^{0.5})$ vs. log T_r for some 35 gases gave different linear curves with different slopes.	23
Uyehara & Watson	A plot of μ_r vs. T_r and P_r. Viscosity calculated from: $\mu = \mu_r\mu_c$.	For nonpolars, error is often <5% when one experimental μ_g value and corresponding μ_c chart value are used.	Not good for highly polar gases. Correlation includes pressure effect and applies to some extent to liquids also.	24, 25
	μ_c may be calculated from: $\mu_c = \frac{61.6\,M^{0.5}T_c^{0.5}}{V_c^{0.667}}$ (a)	For 60 gases, avg. error is 4.6%, max. is 34.2%. This form is best for complex molecules.	Large errors for H_2, He, Br_2. Errors noted at left are those resulting from a comparison of μ_c calculated from Eqs. (a) and (b) with μ_g obtained from μ data and the Uyehara-Watson chart.	24, 25
	or from: $\mu_c = \frac{7.70\,M^{0.5}P_c^{0.667}}{T_c^{0.167}}$ (b)	For 60 gases, avg. error is 6.5%, max. is 62.1%. Best for light gases.		
Brebach & Thodos	A reduced-state plot of μ_r vs. T_r from 0.15 to 100, and P_r from 3×10^{-7} to 100, for the diatomic gases. Also an equivalent "normalized" correlation based on reduction with molecular parameters σ and ϵ/k. Calculate μ_c from: $\mu_c = 7.40\,M^{0.5}P_c^{0.667}/T_c^{0.167}$	For N_2 using about 200 data points for both gas and liquid, avg. error of 1.2%. For 10 other diatomics, avg. error of 1.9%. For diatomic gases generally, accuracy better than that of earlier correlations; but for polyatomic gases at high pressure, Uyehara-Watson chart is better.	Based on N_2 but applicable to other diatomics. Correlation procedure similar to that used earlier for thermal conductivities of inert gases. Correlation applies to mixtures of diatomic gases containing no H_2, He or Ne, by using Kay's rule.	26



On the premise that this superiority would also hold true for viscosity, we combined Eqs. (4), (10), (13) and (14) to yield:

$$\mu_g^\circ = \frac{(M\,T_b)^{0.5}}{V_b^{0.667}}\,[16.37\,(T/T_b)^{0.445} - 5.5/(1.18\,T/T_b)^{0.9\,\log\,(1.18\,T/T_b)}] \qquad (15)$$

A preliminary test of the accuracy of Eq. (15) indicates an avg. error of about 5%.

Eqs. (3) through (15) thus represent the calculation procedure for gas viscosity as developed from the original formulations of Chapman and Cowling[9] by Hirschfelder and coworkers, and as modified to slightly more approximate forms by others.

Oops, We Slipped

- June 2nd, p. 126—Two lines below Eq. (1), denominator of the bracketed term should be M_1M_2.
- June 2nd, p. 126—Right side of Eq. (6) should be multiplied by 10^{-4}.

Other Useful Methods

For the sake of space conservation we have gathered other useful direct calculation and graphical methods in Tables III and IV on the preceding page.

For the important specific case of paraffin hydrocarbon gases at low pressure, the chart above adapted from Ref. 10 adequately represents the viscosity-temperature-molecular weight relationship.

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Summary of Appraisal Discussion

Legend: S—Strong; W—Weak; X—Neither S or W.

Date.....

Name .....Last Appraisal.....

Position .....Div. & Location.....

Present Position Responsibilities
(As stated in Position Description)

A. Responsibility for Personnel—How is he as a boss for the people for whom he is directly and indirectly responsible?
B. Responsibility for Business Development—
C. Responsibility for Physical Resources—
D. Planning—
E. Decision Making—

Present Position Specifications
(Consider statements in the Position Description)

1. Specialized Knowledge Required—
2. Human Relations Skills Needed—
3. Administrative Skills Required—
4. General Knowledge Required—

Personal

Strongest Asset—
Chief Liability—
What Has He Done to Improve Himself?—
What Is He Doing to Develop His Subordinates?—

Capacity for Growth

Are There Replacements for Him Available?—
What Does He Want to Do?—

Developmental Action

Appraisal Made By

Name.....Position.....
Name.....Position.....
Name.....Position.....
Name.....Position.....

How to Measure Individual Performance

After you build a formal yardstick to measure engineering effort, next step is to evaluate the individual in his particular job.

Robert G. Trout, Peerless Pump Div., Food Machinery & Chemical Corp., Los Angeles, Calif.*

Job evaluation can be subjected to emotion, lack of objectivity and favoritism as well as other evils that lead to unfair practices, hierarchies within the department, a minimum of personal development and low department morale—unless a scientific and consistent approach is used.

Our intent in this series of two articles (for Part I, see *Chem. Eng.*, Sept. 8, 1958, p. 146) has been to explain our system of job evaluation. We believe that this system provides a basis for just wage and salary administration administered with maximum objectivity and in a manner such that differentials are explainable by logical reasoning.

We have been using this system successfully in a 70-employee engineering department.

Individualize the Problem

As described in our first article, the job description helps us categorize jobs and their requirements. Now, we come to the problem of how you explain to an individual why he is or is not placed in a certain position. In other words, we must evaluate the performance—in a scientific manner—of the individual within the scope of the defined job.

Researchers in this field give four common solutions to the problem of evaluating individual performance. This author would like to add a fifth and sixth solution. These are:

1. Unilateral judgment.
2. Graphic rating scale.
3. Critical incident technique.
4. Unguided committee evaluation.
5. Guided committee evaluation.
6. Combination of the above.

The unilateral judgment is just what it says. The boss decides what is to be done and his orders are carried out. This method can be effective in smaller organizations which is where it finds its widest use. In large organizations this method can be subjected to many of the evils we are trying to avoid.

* Meet your author next page.

A graphic rating scale is nothing more than a plot of years in the job, or years out of college, vs. salary. It works surprisingly well, but advancement is predicated almost solely (unless this method is used in combination with other methods) on seniority. Thus the advancement of brilliant young men may be retarded to the point where they leave the company.

Oversimplifying a bit, the critical-incident technique consists of either creating or observing one or more incidents in which the jobholder's performance can be observed and measured accurately This method can give good results only if the incidents are representative of the jobholder's real, normal performance.

It's very difficult for this to occur and results of critical-incident measurement are not completely reliable.

Unguided Approach Is Good

The unguided committee approach is very good and is used in many companies. A committee is appointed which considers an incumbent's performance as related to his job description. Good results and plenty of ideas can be obtained about the jobholder if the reviewing committee consists of the jobholder's immediate superior, an associated-department supervisor (same level as incumbent's supervisor) who is familiar with the reviewee's work, a third supervisor who only has occasional contact with the jobholder and someone to act as recorder.

This group is small enough to act effectively and yet large enough to provide realism and objectivity. The committee rates the reviewee's performance on each phase of the work, after some discussion. Rating scheme is usually: strong, weak, neither; or satisfactory, unsatisfactory, very satisfactory, etc. The only difference in this method and the guided-committee approach described below is that the reviewing committee is not uniformly directed so they may completely forget to consider some facet of performance which might be significant.

We Recommend Guidance

We recommend a guided-committee approach for these reasons:

- High degree of objectivity.
- Uniform, directed method of evaluation so it is unlikely that a significant thought will be overlooked (not so with an unguided committee).
- Firm basis for developmental counseling.
- Provides firm, reasonable, explainable basis for merit increase and/or promotion or lack of same.

Guided committee setup is the same as that for the unguided-committee approach. Meeting times can be pre-arranged, usually the week prior to the employee's anniversary date.

The method of operation is to give each reviewer a checklist which shows the significant facets of each category of the job. The first category of the job description is then read and discussion ensues, often started by the immediate supervisor. The guidance sheet may suggest, for example, under responsibility for personnel, these subheadings:

1. How is he as a boss?
2. How well does he motivate his subordinates?
3. Do his subordinates make efficient use of their time?
4. Is his group the focal point of dissension, etc.?

As the reviewers' comments begin to thin out during the discussion, the recorder tries to sum up the discussion with one sentence and he suggests an over-all rating. After the committee as a whole agrees upon a rating, the job description for the next category is read. The process is then repeated and a rating agreed upon for each category in the job description until all points have been covered.

Thus, the reviewing committee has rated the employee's performance on a firm, objective basis against a known measuring stick—the job description.

Generates Useful Byproduct

Evaluation of the jobholder using the guided-committee approach automatically gives the line supervisor an excellent tool for employee development. This is the counseling interview with the employee wherein the committee's evaluation is reviewed with the employee himself.

It's natural for the reviewing committee to evolve recommended developmental action, strongest asset, and weakest asset during the course of the review. These are usually recorded and discussed with the employee during the counseling interview.

Such a discussion can be unemotional, objective and accurate since the evaluation process has evolved a high degree of accuracy and objectivity.

Using the method outlined in these two articles we believe that we have been able to develop a just wage and salary administration, administered with maximum objectivity and in a manner such that any salary differentials are explainable by reason. By reaching this goal we expect to be rewarded with the benefits of high group morale, good motivation of engineering effort, a high degree of cooperation and increased departmental efficiency.

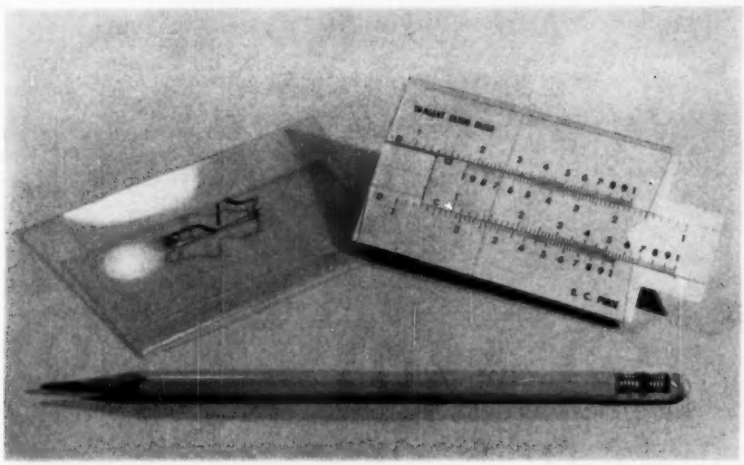
ROBERT G. TROUT *is divisional development supervisor of the Peerless Pump Div., Food Machinery & Chemical Corp. in Los Angeles. He's a native Californian with a B.S. in mechanical engineering from Cal Tech. After duty with the Navy in World War II, he went to work for Peerless in 1946 as a junior engineer, progressing through succeeding positions of junior designer, designer, asst. design supervisor, design supervisor to his present position. He now shares with you some of his vast experience.*

Next Issue

There are those who claim that professionalism and unionism are incompatible; that if engineers want unions they must accept the consequences. In our next issue, look for the bipartisan report of what happened recently when engineers and scientists struck the Camden plants of RCA. "The Story of the $18,000/Yr. Pickets."

PRACTICE . . .

DESIGN NOTEBOOK EDITED BY T. R. OLIVE



If you've wondered what to do with plastic lapel badges, here is your answer! They can make first-class wallet-size slide rules.

Here's Your Wallet-Size Slide Rule

E. C. Pirie, Rochelle Park, N. J.

Shown above is a do-it-yourself gadget that has solved two vexing problems for me: It has insured my having a slide rule with me at all times—ordinary "pocket" slide rules always being in the wrong suit. And it has solved the pressing problem of what to do with those plastic lapel badges we all collect at conventions and expositions.

Solution of this double problem is the wallet-size slide rule. Any engineer can make one—or a half a dozen if he wants—with ease and dispatch. The rule is so small that it takes up no more room than a driver's license. And, like my license, it's always with me.

Construction is simple and almost obvious from the photograph. First the pin is removed from the transparent badge holder and then a line is scribed on the front. The holder becomes the cursor as well as the case. Since these badge holders come in various sizes you will have to select the size you prefer to use. Mine is 3.4 x 2 in. and the "works" is made to fit this.

Long ago, when I made my first badge-holder slide rule, I trimmed two cards to fit the holder, then pasted a piece of log paper onto each. This worked, of course, but it was neither particularly attractive nor professional looking. Recently, when I decided to try my hand at a better rule, I drew it as I wanted it —however, making it four times actual size for accuracy. What I did, you can do.

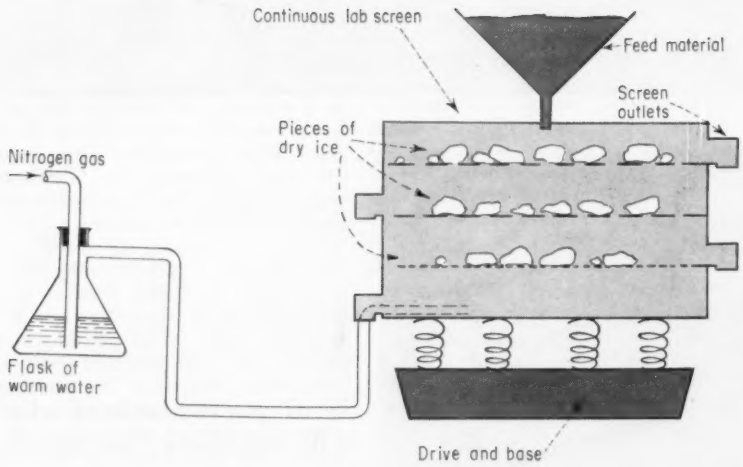
The drafting is easy. The calibrated length of my rule is 2½ in. First I drew two parallel lines 2½ in. apart—India ink, of course—then with a T-square transposed the wanted divisions from ordinary log paper. For a 4:1 reduction a 10-in. log cycle is therefore perfect. Don't forget the reduction or you will put in too many divisions. Finally, paste on some numbers and letters as shown.

What scales you will use depend on your particular needs. You can, within reason, add as many as you want. The *C* and *D* scales, I think, are enough for simple calculation, but I also added the *D* and *CI* scales to avoid having to move the slide from side to side. With this combination, most operations can be made with the slide out at the right.

After you've made your drawing, get a half-size negative photostat. This will show some white spots and white lines around the numbers and letters but can be touched up easily with India ink to hide these imperfections when you get your positive photostat. This again is half size, so the final result has black lines on white background, very clear and sharp from the reduction, and one-quarter the size of the original drawing.

To convert the photostat into the slide rule I first cut up a 3 x 5 file card, cutting a slide ⅜ in. wider than the rule slide. The card's two remaining pieces I pasted onto another file card so the cut-out piece can slide between them. Then I cut up the photostat along the lines separating the scales. The two sides I pasted onto the cards that form the bottom of the rule. The rule slide, pasted onto the cardboard slide, runs between them to form the slide rule.

Now, the gadget is ready to trim and put into its cursor, the plastic badge holder. The result will be neat, compact and available—as accurate and usable as any 2½-in. slide rule can be.



Kill Static in Lab Screening

Merton Allen

General Engineering Laboratory, General Electric Co., Schenectady, N. Y.

Screening solid particles often becomes practically impossible due to build up of static electricity charges on the particulate material. This is especially true if one is screening materials of a high dielectric strength, such as most of the common plastics.

In commercial screening equipment, static is eliminated by use of ionized air from ultra-violet or x-ray excitation. The ionized air contacting the charged particles causes them to give up their charge and the air becomes deionized. This technique is virtually impossible to use in the laboratory when using either hand screening or small portable continuous screens.

Recently we encountered this problem in the laboratory screening of spheres of polystyrene plastic. After much trouble and experimentation we adopted the simple expedient of using moisture to prevent static charges and successfully screened over 1,000 lb. of material.

The diagram above shows how pieces of dry ice were placed on each screen, while humidified nitrogen gas passed upward through the screens countercurrent to the particle path. (We used nitrogen instead of compressed air to eliminate contamination of the material by oil from the air compressor.)

The dry ice cooled the particles to below room temperature. The contact of the cold particles with the humidified gas stream caused condensation of water as a thin film on the particle surfaces. This moisture prevented static charge accumulation.

After the screening operation, we spread the wetted product particles out in a thin layer and allowed them to come to equilibrium with the moisture content of the atmosphere. Hence, the final particles were no wetter than the initial unscreened material. The water film did not hamper the separation in any way, and a high screening efficiency resulted.

New Data Supplement Liquid Viscosity Chart

Jerome A. Seiner

Development Engineer, Springdale Research Center, Pittsburgh Plate Glass Co., Springdale, Pa.

Tabulated below are coordinates for viscosity data on 45 liquids. These supplement the list of 110 liquids now included on p. 372 of the 3rd Edition of Perry's "Chemical Engineers' Handbook." These coordinates are for use with the chart on p. 373 of the Handbook.

Liquid Viscosity Coordinates

Chemical	X	Y
Acetonitrile	14.4	7.4
Acrylic acid	12.3	13.9
Allyl bromide	14.4	9.6
Allyl iodide	14.0	11.7
i-Butyl acetate	13.1	11.3
n-Butyl acrylate	11.5	12.6
i-Butyl bromide	13.1	10.9
i-Butyl chloride	13.1	9.1
i-Butyl iodide	13.3	12.4
Cyclohexane	9.8	12.9
Diethylene glycol	5.0	24.7
Diethyl ketone	13.5	9.2
Dipropyl ether	13.2	8.6
Ethyl acrylate	12.7	10.4
2 Ethyl butyl acrylate	11.2	14.0
Ethylene bromide	11.9	15.7
Ethylene chloride	12.7	12.2
2 Ethyl hexyl acrylate	9.0	15.0
Ethylidene chloride	13.6	9.5
Fluorobenzene	13.7	10.4
Iodobenzene	12.8	15.9
Methyl acrylate	13.0	9.5
Methyl n-butyrate	13.2	10.3
Methyl i-butyrate	12.3	9.7
Methylene chloride	14.1	8.7
Methyl formate	14.2	7.5
Methyl iodide	14.3	9.3
Methyl propionate	13.5	9.0
Methyl propyl ketone	14.3	9.5
Methyl sulfide	15.3	6.4
Nitrogen dioxide	12.9	8.6
Propyl acetate	13.1	10.3
i-Propyl bromide	14.1	9.2
i-Propyl chloride	13.9	7.1
Propylene glycol	3.1	23.7
Propyl formate	13.1	9.7
i-Propyl iodide	13.7	11.2
Succinonitrile	10.1	20.8
Ethyl propionate	13.2	9.9
Ethyl propyl ether	14.0	7.0
Ethyl sulfide	13.8	8.9
Sulfuric acid (100%)	8.0	25.1
Thiophene	13.2	11.0
Triethylene glycol	4.7	24.8
Vinyl toluene	13.4	12.0

NEXT ISSUE: Tank Control Siphon Can't Lose Prime

By C. F. A. Roberts, Winner of the July Contest

★ How Readers Can Win

$50 Prize for a Good Idea—Until further notice the Editors of *Chemical Engineering* will award $50 each four weeks to the author of the best short article received during that period and accepted for Plant or Design Notebook.

Each period's winner will be announced in the second following issue and published in the third or fourth following issue.

$100 Annual Prize—At the end of each year the period winners will be rejudged and the year's best awarded an additional $100 prize.

How to Enter Contest — Any reader (except a McGraw-Hill employee) may submit as many contest entries as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 500 words, but illustrated if possible. Acceptable non-winning articles will be published at space rates ($10 minimum).

Articles should interest chemical engineers in development, design or production. They may deal with useful methods, data, calculations. Address Plant & Design Notebooks, *Chemical Engineering*, 330 W. 42nd St., New York 36, N. Y.

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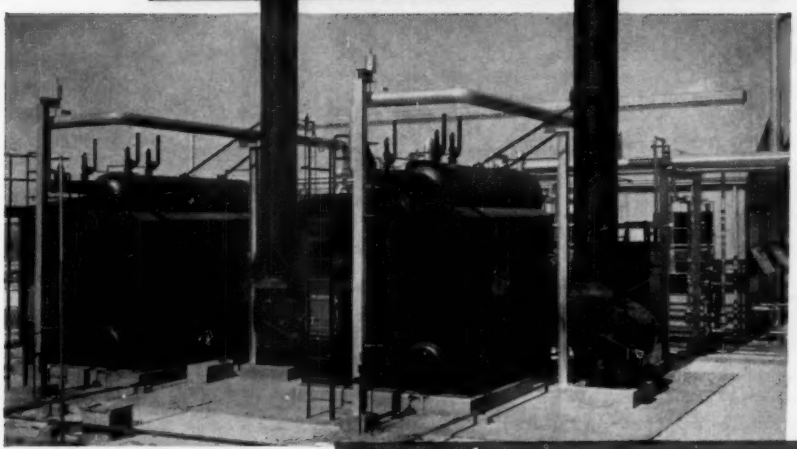
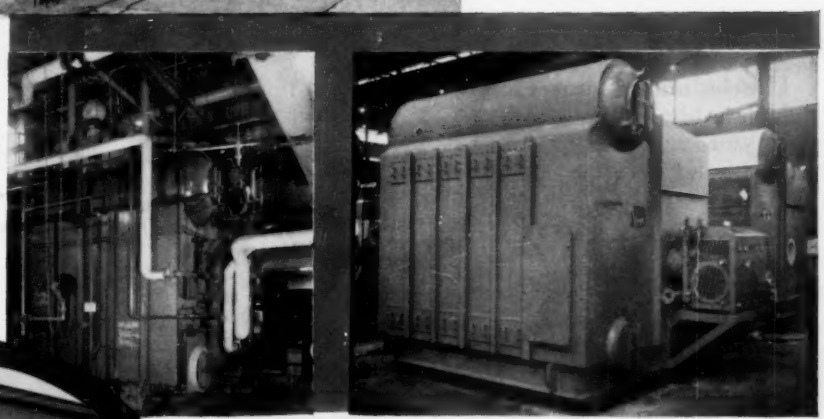
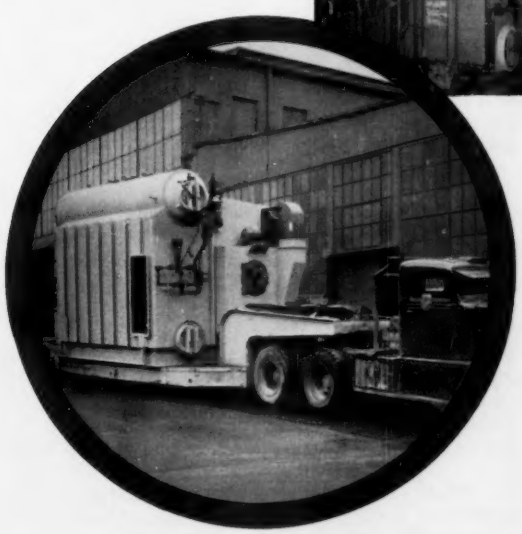


Above: Two units serve a gas pipeline company.

Left: Installation in fibre boxboard plant.

Right: Unit for a leading soap manufacturer.





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Use the manufacturer.
He's a big help
to you in . . .

. . . Ordering Mechanical Seals

HAROLD BARTZ, Chemical Engineer, A. E. C., New York Operations, New York, N. Y.

How many articles on the principles of mechanical-seal operation have you seen recently? Every chemical engineer reading these articles should, by this time, be an expert on their application.

When a seal is required, you simply specify the seal combination you've concocted and place your order. However, at this point your trials and tribulations really begin.

The Vendor Needs Information

For some obscure, unscientific and wholly unsatisfactory reason, the seal manufacturer asks questions about the conditions of operation of the seal. He usually does this with a blank data sheet. Now, for what possible reason are the conditions of operation of your secret dehydrated water process any of the seal manufacturer's business?

At this point you can resolve the whole problem. One statement on your order does it: your company accepts responsibility for application of the seal.

Strange as it sounds, seal manufacturers stand behind their products if properly selected and applied or if the application is checked by one of their engineers. You don't have to accept complete responsibility for the application.

Mechanical seals can be more expensive than the pump of which it's a part. Suppose you bought a seal and incorrectly applied it. Would you admit you selected the wrong (or not the best) seal for the job? Probably not. Who would?

This is the very reason for the seal vendor's apparent prying into your operation.

We don't want to rehash seal principles and applications. We'll just show why some information is required by the seal vendor for correct application of his products.

Many Questions to Answer

The seal vendor has to have a fair knowledge of the conditions the seal will operate in:

- Dimensions of the seal.
- Liquid handled.
- Suction pressure.
- Temperature.
- Presence and nature of solids.

There are many questions to answer when selecting the proper mechanical seal.

Materials of construction must be inert to chemical attack from the liquid handled. Generally, a seal consists of a metallic and a nonmetallic face in contact with each other. If one face is carbon, will the carbon binder resist chemical attack? There are many possible seal-face combinations. Are you qualified to select the best for the liquid you'll be handling?

Does your liquid supply the

From CARBIDE'S solvent center . . .

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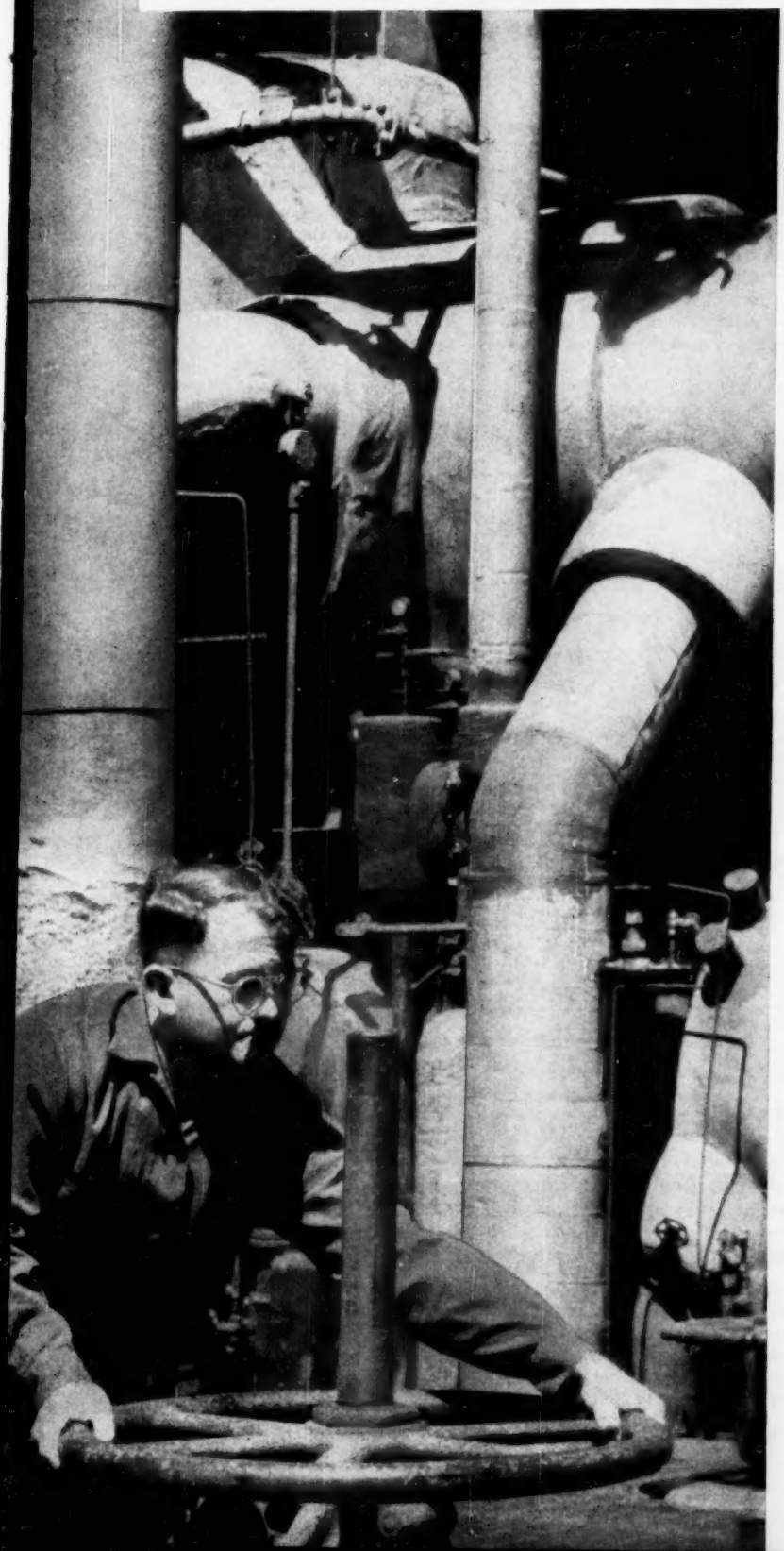

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You can order in compartment tank car and tank truck shipments or combination drum shipments in carload or truck load lots. Thus, you gain considerable savings in filling all your solvent needs. You're assured quick deliveries from 52 warehouses—one of them is located in your area . . . and from fourteen bulk stations and four plants—at Institute, West Virginia; South Charleston, West Virginia; Texas City, Texas; and Whiting, Indiana.

You can also get valuable assistance from one of CARBIDE's Technical Representatives. With his broad industry experience, the CARBIDE representative can give you complete information on Methyl Isobutyl Ketone as well as other ketones. For example, Acetone is a good solvent for protective coatings, duplicating fluids, and in drug extraction; Di-Isobutyl Ketone can be used in vinyl coatings and nitrocellulose lacquers; and Isophorone is an excellent solvent for vinyl coatings used as linings for food and beverage cans.

For information on applications and specifications for Methyl Isobutyl Ketone and 14 other ketone solvents, write for the booklet, "Ketones." For aid in selecting the proper solvent to strike the best balance between cost and performance in your formulations, send for the handy 6-page booklet "Solvent Selector"; it gives complete data on 70 solvents. Write . . . Department H, Union Carbide Chemicals Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, New York.

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UNION CARBIDE CHEMICALS COMPANY

DIVISION OF UNION CARBIDE CORPORATION

necessary lubricating qualities to insure long seal-life? For example: hydrocarbons of low specific gravity (under 0.7) may not have lubricating qualities.

Terrific heat is generated by a rotating seal face in contact with a stationary one. Do you know what modifications are available to overcome this problem?

Is your liquid toxic? Seals can be modified to safely handle toxic or volatile materials.

Suction pressure is a major factor. Springs under tension are commonly used to keep the faces of a seal in contact with each other. Tension available in these springs is limited. At very high pressures, balanced or double seals may be called for. These are expensive.

Temperature of the liquid can be critical. You have a high-speed rotating shaft and close tolerances. Thermal expansion varies for the different materials used.

If your seal has a nonmetallic part, thermal shock may also be a factor. Seals can be flushed, lubricated, quenched and cooled. Which is best for your job?

Last factor is a statement on solids present. Soft, nonabrasive solids that don't crystallize, shouldn't be a problem. However, if your liquid solidifies and welds the seal faces together, you can wreck the seal when you start the equipment. Steam or hot liquid, properly applied, prevents this.

For abrasive solids, special materials of construction are available. Liquids introduced at the seal faces prevent the entry of solids between the seal halves.

One other point of importance—is the rotating shaft of your pump in new condition? To seal effectively, there can't be any scratches of consequence at the point of contact between the rotating seal element and the shaft. A new shaft or shaft sleeve is a wise investment when you're buying an expensive seal. You can save money by spending money.

Most Points Are Common Sense

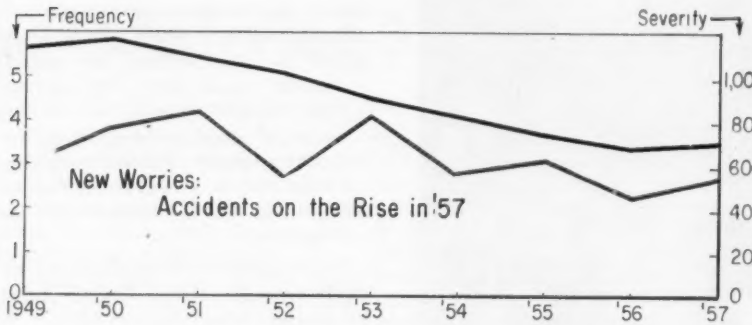
Problems that arise are usually due to a misunderstanding of the seal vendor's reasons for asking questions. Your information is confidential and is treated as such.

The application engineer's experience in solving your problem was gained in solving similar problems for others. All the latest improvements and techniques are yours for the asking.

However, you must realize that if you radically change the conditions of operation, your seal may fail. You should verify any new application of existing equipment before starting operations. Inexpensive modifications are frequently availble. Your guarantee won't apply if you don't operate the seal as originally specified.

All of the above points are really common sense. Some seal manufacturers require extra information. There's a good reason for this. If you take a look at the construction of their particular seal you'll find the answer.

In all cases, one fact stands out. Satisfied customers are their best advertisement. Your cooperation is needed by the seal vendor so that he can do the best job to meet your problem.



Organize for Safety

Safety committees can head off rising accident rates. Try organizing one in your plant.

JACK BEDFORD, Armstrong College, Berkeley, Calif.

For the first time in seven years, the chemical industry has a double cause to worry. Both accident frequency and severity rates rose in 1957.

According to the National Safety Council, the accident frequency rate in the chemical process industries increased 5% to 3.55 disabling injuries per million man-hours worked. At the same time the severity rate increased 16% to 536 days lost per million man-hours worked.

These safety records show it's time for you to take a good, long, hard look at your safety programs and measures.

Why did this rise occur and what can you do to stop this dangerous trend in your plant? Some of the accidents are because you've added new employees and these people aren't safety conscious. Others occur because old employees sometimes grow lax in observing safety rules established to reduce the accident rate.

Check your own performance against the national averages. How are you doing? From your computation you can figure the cost per employee on a financial basis but you'll never be able to figure the other factors. How do you account for the physical pain a man suffers when injured?

There are other costs—intangible costs—hard to compute.

- It takes time and money to break a new man into a job after an accident.
- Production drops when you

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Now your pails can pour freely —without sputter, gurgle or stoppage

If your products will pour, they will pour *freely*—in a controlled stream—through these new double-barrelled Tri-Sure* 1¾" Screw Type and 45MM Upressit Push-Pull Spout Assemblies.

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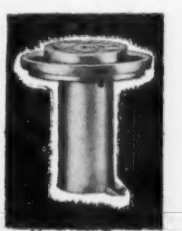

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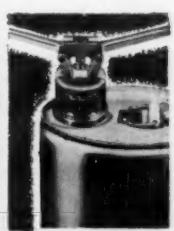


Clinch-On Tool

AMERICAN FLANGE & MANUFACTURING CO. INC., 30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

transfer another employee into an accident victim's work.

• If your accident rate is high your insurance rates will climb.

When you're convinced something must be done to decrease the accident rate, what do you do? Some chemical plants hire safety experts or have someone in the plant assigned as a safety director. This puts one individual in charge of all safety measures and fixes responsibility for any continued high accident-rate.

In many cases, this is too expensive and may not prove satisfactory. It requires an individual who: understands all the work of the organization, inspires workers to observe safe practices, and takes a definite interest in this phase of directing safety in the plant.

Enter the Safety Committee

For the average chemical plant a more practical solution to this accident problem is via a safety committee. A group of supervisors and employees in a safety committee exists for two definite reasons:

• Provide safe education.

• Fix responsibility for carrying out safety programs.

When you're setting up a committee of this sort, select the workers and supervisors with certain things in mind. Both workers and supervisors should make up the committee personnel. This way you avoid the possibility of safety being only by management recommendation. Since workers are on the committee, the rank-and-file of the employees will go along with what the committee recommends.

Be sure there's representation from all activities and especially good representation from the areas where the largest percentage of accidents occur. This proves valuable in developing solutions for safety programs that meet the requirements of all departments. It covers all types of accidents and makes the safety program much better for your plant.

Don't have more than six or eight members on the safety committee. In large organizations the group can be put on a rotating basis. In smaller plants, the number of men on the committee can be set to fit the needs of the plant.

When members of the safety committee are changed frequently, the program's effectiveness is increased. Replacing one-half of the members every six months is a good schedule. This way a worker or supervisor serves for one year. Every six months one-half of the group is new and brings fresh viewpoints. These viewpoints are tempered with the knowledge of the older members of the committee.

Responsibility is Necessary

For best results, the safety committee has five definite responsibilities in carrying out its work:

• Set standards for guarding equipment.

• Formulate safety rules and make necessary changes in existing rules.

• Investigate all accidents in the plant.

• Review safety suggestions presented by the committee and by other employees.

• Make recommendations for changes in system and purchase of safer equipment or attachments.

In setting standards for safeguarding equipment and employees, the safety committee is guided by the present facilities. Standards may be ideal, but if accidents continue to happen in certain areas, you'll be money ahead by adopting new safety standards right away.

Safety rules made by the safety committee are usually better observed than if management passes down a list of directives. Rules made by a group of employees naturally takes the employees interest into consideration. Workers realize this and are willing to follow the safety regulations.

Accident investigation is a continuing process. The investigation answers the important questions of how, who, when, where and why for each accident. When the committee investigates along these lines, they determine what to do to prevent another occurrence of the same type of accident.

Employees generally have suggestions for improvement of safety facilities. Naturally, some of their suggestions aren't practical. With a safety committee to pass on ideas, a great deal of ill-feeling, that sometimes develops when they aren't adopted, is avoided.

Because the committee is close to the problem and is working with safety, it's able to quickly determine if suggestions have some practical value.

In making recommendations, the safety committee covers:

• Changes in safety rules.

• Purchase of new equipment.

• Purchase of safety devices for existing equipment.

• Frequent inspection of certain high accident areas.

• Change of type of employee for certain phases of the work.

Once a week meetings are necessary at the start of a safety program. After the groundwork is laid for the program the meetings can be held monthly.

Hold meetings on company time. When meetings are held after hours, you should see to it that the member's time is compensated for.

When a safety committee is functioning properly, your accident rate will decline. Through a group like this you'll develop a continuing interest in safety in your plant and assure everyone's cooperation with the safety committee.

Now: Color Coding for Tankcars

Color coding by safety-conscious plant men has gone one step farther. Gaining a double in plant operations and aesthetics, U. S. Industrial Chemicals Co. is taking on a new tankcar painting program.

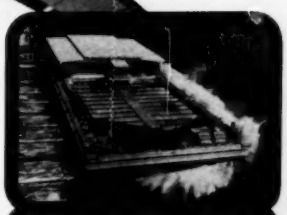
With the painting of U.S.I.'s entire tankcar fleet of 900 cars in a uniform code system, the service for each car is immediately identified. This gives people in plant operations a double check and an at-a-glance opportunity to pick up errors before the cars reach the unloading rack.

Domes of the tankcars are:

	Solid Color
General service (alcohol, etc.)	White
Ethyl ether	Light blue
Chlorine	Light green
Ammonia	Bright yellow
Sulfuric acid	Black
Phosphatic fertilizer solution	Bright orange
Nitrogen fertilizer solution	Bright red
Caustic soda	Maroon
Metallic sodium	Gray
	Black With Stripe
Ethyl chloride	Orange
Olefin	Yellow
Misc., gasoline, waste material	Red

The new corrosion film everyone is talking about!

Here is an authoritative film that answers many questions on the theory of corrosion and demonstrates methods by which it is controlled. Presented in color and sound, it ranges from the formation of anodes and cathodes through the use of galvanizing, inhibitors, metallizing, cathodic protection, alloys and protective coatings. You will see how many corrosion problems in industries such as yours are being solved by Dimetcote, a one-coat zinc silicate protective coating. This film will be well worth 19 minutes of your time. To arrange a showing for you and your associates, or to learn when it will be shown in your area, contact any of the Amercoat offices listed below.



Typical audience reactions:

Bishop, Tex.—"Planning fair-sized test after seeing this film."

Louisville, Ky.—"Answers many questions. Second showing arranged."

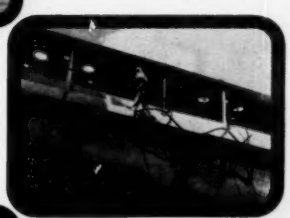
Cincinnati, Ohio—"Key personnel evidenced considerable interest."

Netherlands Antilles—"Both shows led to 45-minute discussions."

Fairport, Ohio—"Very interesting. Will try methods shown."

Las Piedras, Venezuela—"Putting ideas to work in near future."

Bartlesville, Okla.—"Viewed by 42 key men from five divisions."



Answers these and other questions:

What produces electrolytic corrosion?

What factors favor hot-dip galvanizing?

How important is surface preparation?

Can a coating survive a tank fire?

Can rust in tankers be controlled?

Can a coating offer cathodic protection?

What are the corrosion problems on offshore rigs?

What are the advantages of zinc silicate?

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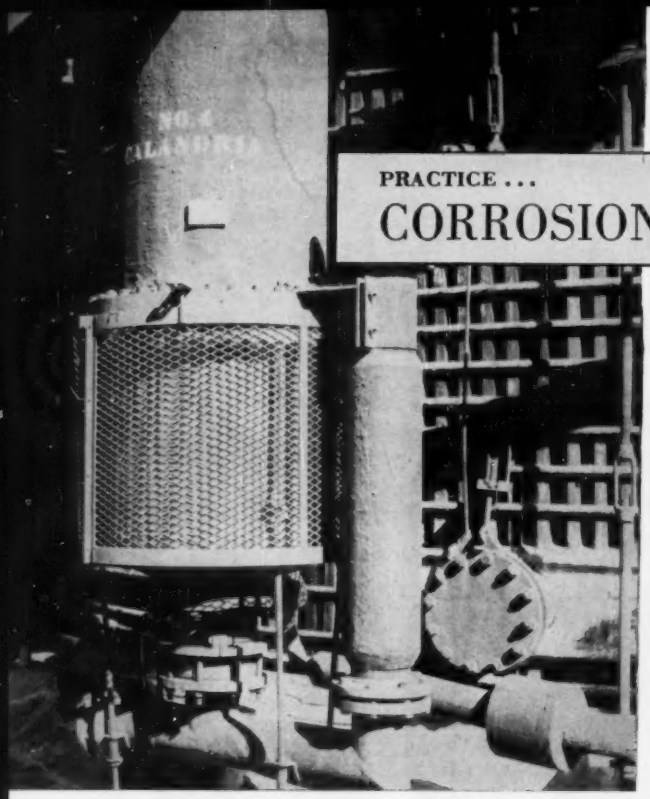
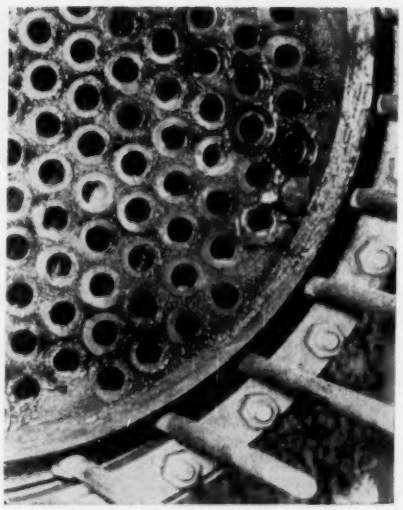


PRACTICE . . .

CORROSION FORUM

EDITED BY R. B. NORDEN



Graphite doesn't corrode in the usual sense, so how do you estimate life of such equipment? From a major user of graphite reboilers (above) come some useful yardsticks.

How Much Life in Graphite Heat Exchangers?

C. P. Dillon, Corrosion Engineer, Union Carbide Chemicals Co., Institute, W. Va.

Economic evaluation of chemical processes requires knowledge of equipment maintenance cost and life of equipment.

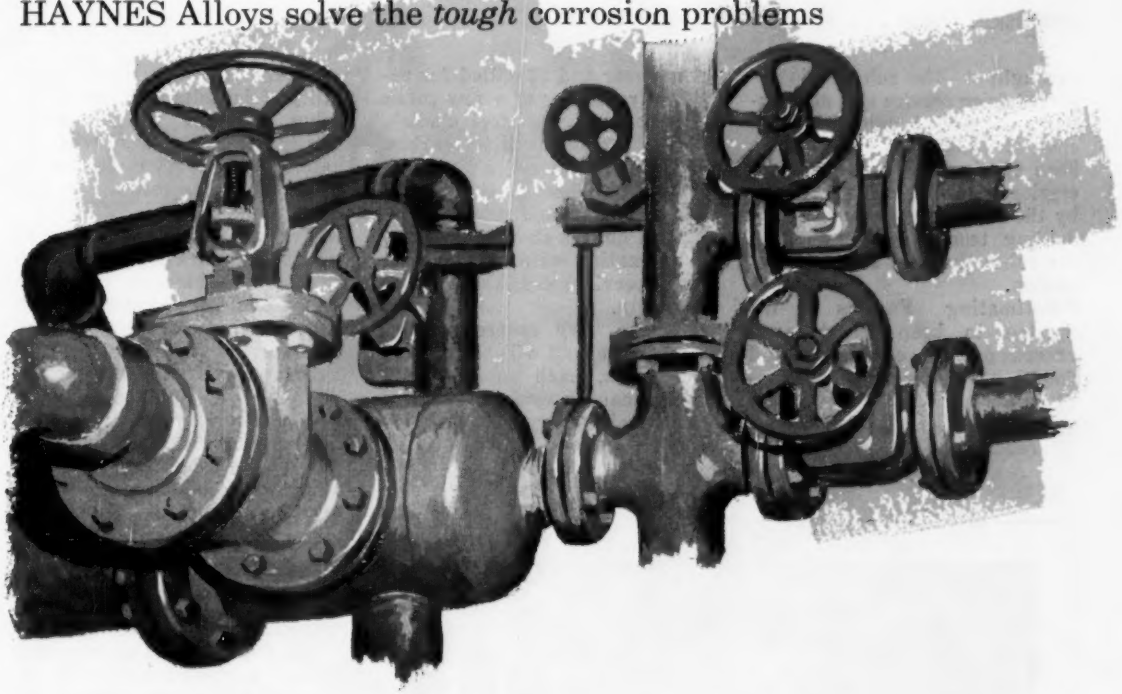
For many services the corrosion rate of metallic equipment has been correlated with field experience to give reasonably accurate estimates of maintenance and replacement costs. In the majority of services for which impervious graphite equipment is recommended, there is no corrosion. But impervious graphite equipment can at times be subjected to stresses exceeding its limitations as, for example, during mechanical cleaning. How, then, does the process engineer estimate the maintenance costs on impervious graphite equipment that is free of corrosion? In the case of heat exchangers, we have some records of interest.

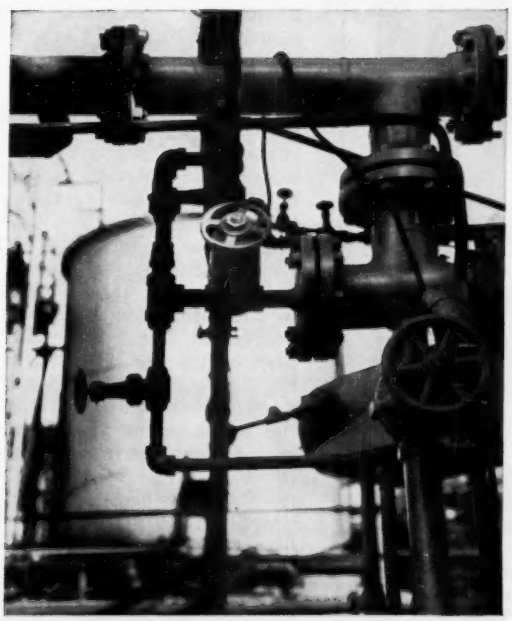
► **Tough Conditions**—Our plant has 16 impervious graphite heat exchangers as vertical reboilers. They are used for the stripping of water and organic material from 45-55% sulfuric acid at temperatures as high as 302 F. At times, steam pressures go as high as 60 psig.

One of the 16 reboilers that has been on stream is shown above. The exchanger shell is steel 30-in. in diameter and the bundle is made up of 241 impervious graphite tubes ¾-in. I. D. by 1¼-in. O. D. by 9-ft. long cemented into impervious graphite tube sheets. Each exchanger provides 740 sq. ft. of heating surface.

The sulphuric acid flowing through the tubes of the reboilers contains contaminants. Eventually stubborn carbonaceous deposits form inside the impervious graphite tubes. When the heat transfer rate is sufficiently reduced—indicated by the steam pressure required to keep the reboiler operating at required

HAYNES Alloys solve the *tough* corrosion problems





Valves previously used lasted only a day . . . but alloy B valves exposed to sulphuric acid and live steam while regulating flow from a neutralizer unit are expected to last indefinitely.

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throughput—the reboiler is removed from service and mechanically cleaned. A number of mechanical cleaning techniques have been developed. Sandblasting is employed for tubes not plugged by the carbonaceous deposits. A drilling technique is necessary for tubes that are closed off by carbon.

▶**Estimating Factors** — We started to keep maintenance records on these exchangers and found that under the severe conditions, where heavy carbon deposits form in the tubes, about 20 reboilers required cleaning every year and 23 called for repairs (replacing of a few tubes and work on the steel shells). Where there was little carbon deposition (after a process change) we had to clean 2 reboilers per yr. and repair 9.

Such figures should be useful in estimating maintenance costs for impervious graphite heat exchangers. Based on these records for very severe service, where a deposit will build up in the tubes, each reboiler will need cleaning every 9½ months and repairs every 8½ months on the average.

Where there is little possibility of deposits forming on the tubes, cleaning will be practically nil. Repairs will be called for every 21 months on the average, according to the above data.

Average annual cost of maintenance for the impervious graphite exchangers has been about $500 per exchanger. Current replacement costs for each is approximately $7,500. The average maintenance cost includes heavy and light carbon deposition.

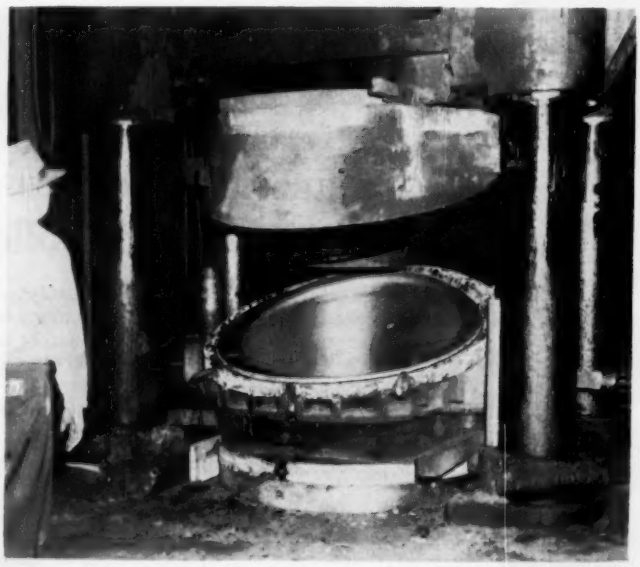
The photograph shows a portion of the tube sheet of one of the reboilers. Machining marks made are still visible on the impervious graphite. Some replaced tubes are shown. Most of the tubes shown are the original ones installed and appear good for many more years.

We feel that the maintenance record of these reboilers is reasonable. The temperatures approach the maximum recommended by National Carbon Co. and steam pressures occasionally exceed the maximum.

Our own experience has shown that for lower temperatures and pressures, maintenance of impervious graphite heat exchangers is a fraction of that experienced with these 16.

▶**Keep Replacing Tubes**—Our study of impervious graphite reboilers in this service has led to an interesting comparison. Sooner or later, the point is reached in the life of most metallic exchangers when it is more economical to replace all the tubes or the entire bundle than to continue replacement of tubes on a piecemeal basis. In the case of these impervious graphite tube bundles, the freedom from corrosion indicates that it will continue to be economical to replace a few tubes at a time indefinitely.

While these 16 exchangers do not entirely answer the question of maintenance costs of impervious graphite heat exchangers, they have established a point of reference. At the other end of the scale, we have other processes using impervious graphite coolers that have operated at 140 F. and 25 psig. for more than 10 years without any maintenance. (*Continued*)



Salvage Operation Saves 1,000 Steel Nozzles

The situation: 1,000 five-ft.-dia. forged steel nozzles all with the wrong flare radius, which produced detrimental turbulence in gas flow. The problem: scrap and buy new nozzles or rework? The answer: rework and save 75% of the cost of new nozzles.

This is no hypothetical situation, but an actual rework job recently completed by Standard Steel Works, Burnham, Pa. (division of Baldwin-Lima-Hamilton). The nozzles, plated on the inside to resist corrosion, are intended for use in separation of U-235 and 238 in Atomic Energy Commission plants at Oak Ridge, Paducah and Portsmouth. They all had a sharp 1¼-in. flare radius, which had to be changed to 7¼-in.

First step in the re-forming process was to design two complicated dies—a one piece upper and a two-piece lower. Then the dies were placed in a 2,500-ton hydraulic press (above). Each nozzle was heated to 1,800 F. before going into the press.

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The 4" Durco Type F valve with renewable Teflon sleeve is now available from stock in Durimet 20 and Durco 18-8-S-Mo. This non-sticking, non-lubricated heavy duty chemical service valve is also available on special order in a wide variety of alloys including Chlorimet 2, Chlorimet 3, Monel, Nickel, and Inconel. Call or write

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New Coatings Boost Graphite Applications

New high-temperature coatings for graphite, which keep the graphite from burning or eroding, have recently been announced by Minnesota Mining and Manufacturing.

Various graphite shapes coated by the new 3M process have been subjected to temperatures from 1,800 to 2,700 F. for several hundred hours without measurable oxidation of the graphite, and immersed in boiling acids (including aqua regia) for weeks without damage. Shapes have also been exposed to 1,600 F. steam and carbon dioxide (in separate tests) for several hundred hours without damage. Graphite is known as a material with many valuable properties, but it usually will burn at high temperatures and erode under high velocity gases.

According to 3M, application of this impervious coating produces no undesirable changes in the physical properties of the graphite. "This permits us, for the first time, to take advantage of the excellent heat shock resistance of graphite, and its other desirable characteristics, under high temperature oxidizing conditions," according to N. H. Stadley, coordinator for graphite coatings research.

Coatings applied to date have varied in thickness from 0.001-in. to 0.010-in. Maximum satisfactory thickness depends on the end use of the coated item. Experience indicates that even thicker coatings can be successfully applied.

Ability to produce specific sizes and shapes of coated graphite are limited only by the forming equipment available at the moment.

Applications for the new graphite coatings in the chemical field would primarily involve processing equipment in which high-temperature materials, exceedingly resistant to acids and to oxidation, are required. Or where imperviousness is important.

Coated graphite might be used for tubing, containers, pipes, stirring rods or other components of chemical processing equipment.

Applications in the metallurgical field, according to 3M, would involve many of the same general considerations as those in the chemical field. New coated graphite materials might be valuable as refractories or molds in which molten material attacks equipment, or where part of the processing equipment is exposed to air.

Also in the metallurgical field, the new coated graphite is undergoing evaluation as a material for thermocouples where very high temperatures, severe oxidizing conditions and considerable abrasion are present.

In the missile field specimens have been exposed to high velocity oxidizing gases at temperatures in excess of 5,000 F. Repeated bursts of short duration left the graphite and the coating undamaged. Only after prolonged continuous exposure was the coating penetrated. Because the coating prevents combustion of the surface, it permits graphite to serve as a heat sink (or heat absorber) increasing its value in certain missile applications.

Initial shape and size of graphite are unaltered by the coating process. The only dimensional change is that from the thickness of the coating itself, so lightweight structures can be produced—graphite may be formed as a shell and coated.

Another big field for the 3M graphite coatings: commercial nuclear applications. Coated graphite appears promising in moderators and structural components (such as coolant tubes, control rods, heat exchangers) for reactors, pointing the way, according to 3M, to high-temperature reactor systems with considerably greater efficiency than reactors now in operation.

As an example, pellet-type uranium oxide and thorium oxide fuel elements are encased in metal. It's now possible to use the coated graphite as a high-temperature cladding.

3M also has a new process for bonding graphite, which is said to be superior to previous graphite bonding techniques.

The new materials were developed in the Nuclear Research section of 3M's Central Research Laboratory. Commercial production will be handled by American Lava Corp., a wholly owned subsidiary located at Chattanooga, Tenn.

New Cermets for 2,200 F. and Above

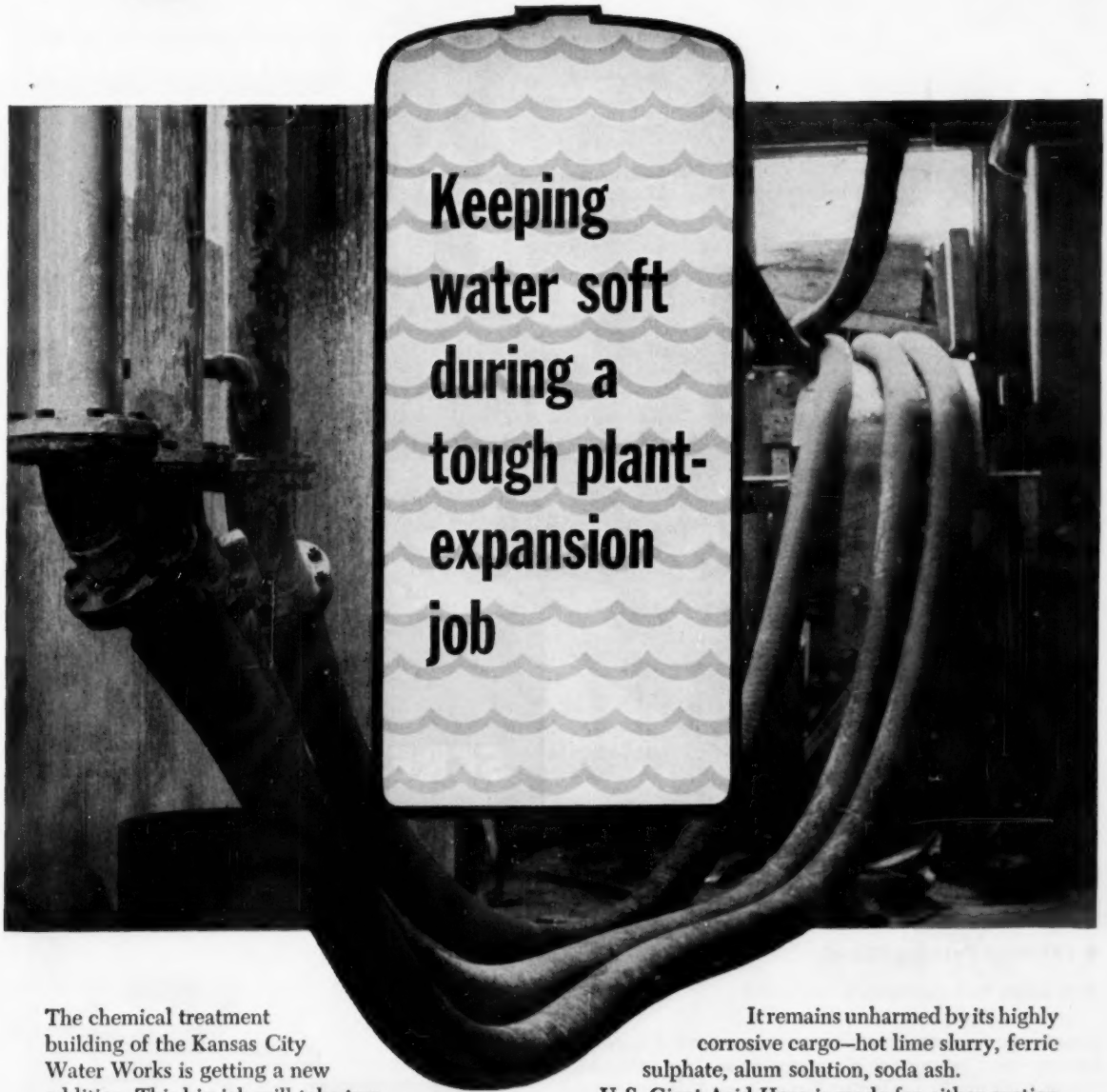
High-temperature materials are definitely in the news this month. A relatively new group of materials—metal-ceramics—are attracting much attention among chemical engineers.

Metal-ceramics—actually hybrid refractory materials—can stand temperatures up to and above 2,300 F. A range of compositions are available: some of these "cermets" contain chromium and alumina, others have tungsten. The combination of ceramic and metal provides properties of strength and high-temperature resistance.

Applications in the chemical industry have been very limited up to now. But it's known that one chemical company is using a metal-ceramic mechanical seal ring on a process pump. The material is Haynes Stellite LT-1 (77% chromium, 23% alumina). Material handled in the centrifugal pump: a slurry of alkyl benzene and oleum. The slurry, of course, is very abrasive. Usual seals failed after a few weeks, but so far the metal-ceramic seal, which remains stationary as a carbon seal ring turns against its interface, has been in for six months.

This is not to say that metal-ceramics haven't any limitations. They are stronger than ceramics, but still brittle compared to metals. They can't be used under high stress or where mechanical shock can do damage. And they can't be used in carburizing atmospheres, which embittle them and create dimensional distortion.

US RUBBER GIANT ACID HOSE



Keeping water soft during a tough plant-expansion job

The chemical treatment building of the Kansas City Water Works is getting a new addition. This big job will take two years, during which time the building contractor is using a simple and economical means for conveying water-softening chemicals to the water supply.

He uses chemically-resistant U.S. Giant® Acid Hose, furnished with stainless-steel fittings.

The men find it extremely flexible and easy to handle, resistant to abrasion, impact and weather.

It remains unharmed by its highly corrosive cargo—hot lime slurry, ferric sulphate, alum solution, soda ash.

U.S. Giant Acid Hose is made for either suction or discharge service, replacing metal pipe because it handles highly corrosive solutions so well.

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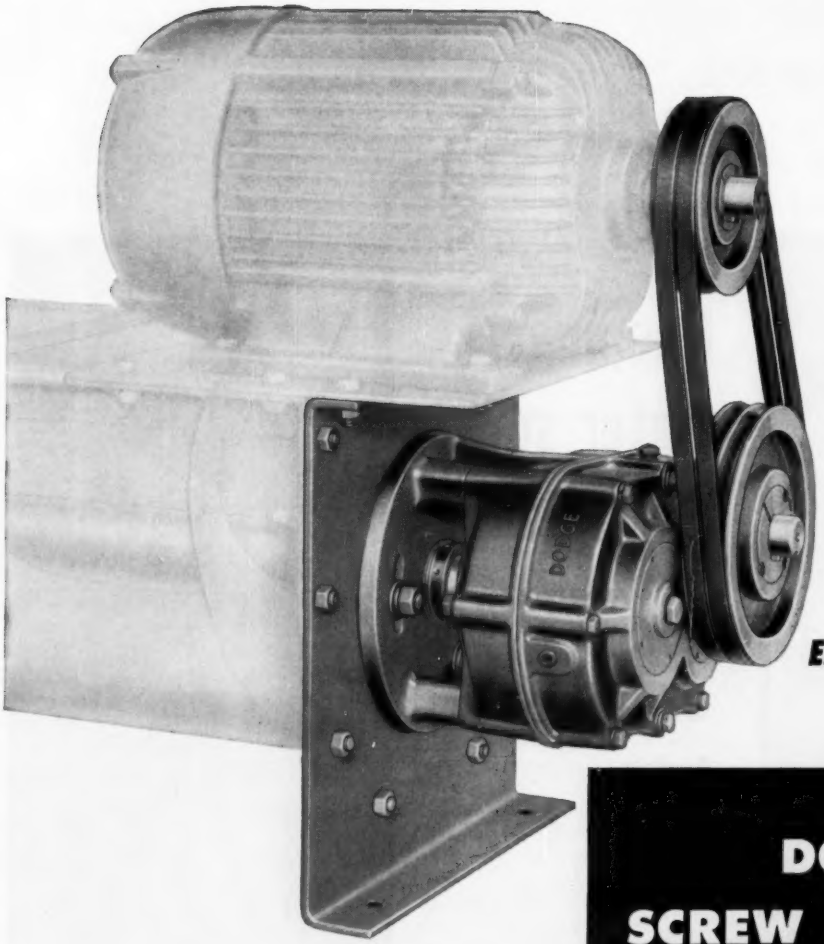

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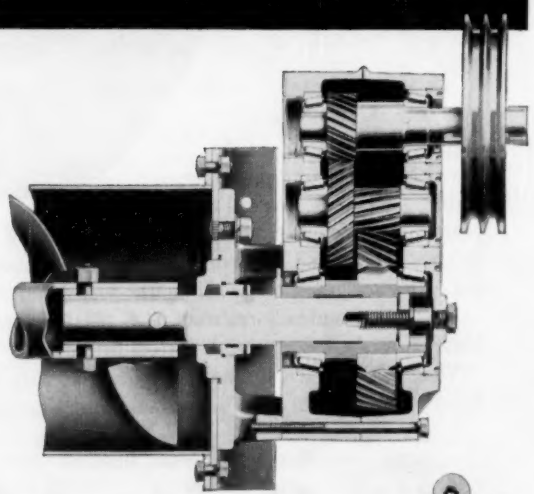

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FIRMS IN THE NEWS

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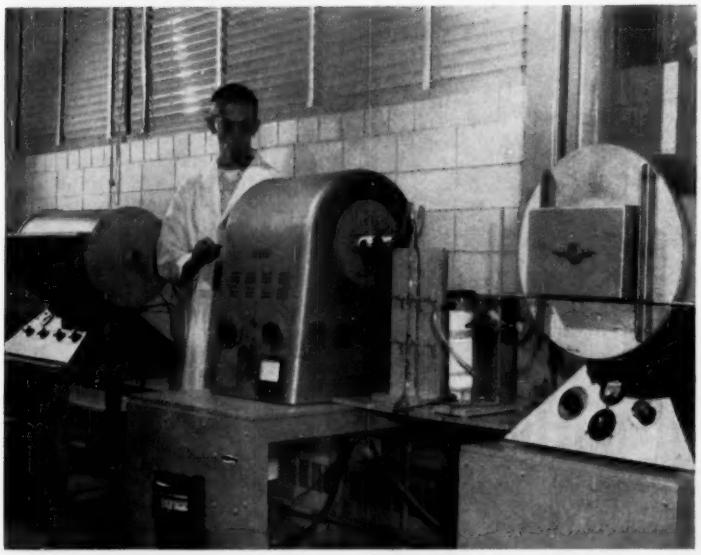
NEW FACILITIES



New Alloys Face High-Temperature Punishment

Haynes Stellite Co. is putting its newly developed alloys through stiff oxidation tests at over 2,000 F. in a new corrosion testing laboratory at Kokomo, Ind. Part of a multimillion-dollar expansion program, laboratory screens alloys for possible high-temperature chemical process service.

Humble Oil announces details of its new polypropylene plant (*Chem. Eng.*, July 14, p. 166): Plant at Baytown, Tex., is scheduled to start production late next year with annual capacity of 40 million lb., expandable to 100 million lb. Enjay Co., subsidiary of Standard Oil of New Jersey, will market the polypropylene through its own sales organization; Spencer Chemical will also sell some of the plastic.

Pan-American Petroleum Corp. is starting construction on a natural gas processing plant about 10 mi. south of Riverton, Wyo. Cost will run around $2.5 million, capacity will be 47 million cu. ft./day. Unit will recover propane, butane and natural gasoline.

Congress has OK'd $11 million for construction of a helium production plant near Keyes, Okla.; another $1.1 million is also available for the new plant from prior appropriations. The Keyes field contains around 2% helium which is presently being lost as the gas is burned for fuel.

Reichhold Chemicals has just doubled pentachlorophenol capacity at its Tacoma, Wash., plant. Bulk of increased output is tagged for wood-treating industry in Pacific Northwest.

Goodrich Chemical is in production at its newly completed glacial acrylic acid plant at Calvert City, Ky. With capacity of "several million lb./yr.," plant marks first commercial production of this highly reactive monomer. Acrylic acid imparts increased adhesion to many

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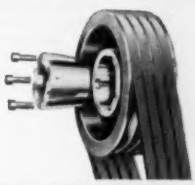

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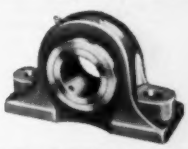

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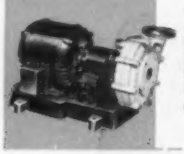
"WAM" PUMP *finest you can buy*



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ACE-ITE *all-purpose toughie*

High-impact, rubber-plastic, most economical for average chemicals. ½ to 6". Screw or solvent welded fittings. Valves ½ to 2". NSF-approved. *Bul. 80A.*

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All-purpose rigid PVC. Sched. 40, 80 & 120, ½ to 4". Threaded or socket-weld fittings. Valves ½ to 2". NSF-approved. *Free Bul. CE-56.*

Still bothered by corrosion?

Downtime, ruined equipment, endless repairs are more than disturbing... they're expensive too. You can put an end to 85 to 100% of your corrosion and contamination losses by specifying chemical-resistant Ace rubber and plastic equipment... pipe, valves, tanks, pumps. American Hard Rubber Company's 108 years of experience is ready to help you with any problem.

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FIRMS . . .

resins and plastics, or can be polymerized alone to make water-soluble resins.

Texaco awarded contract recently to Bechtel Corp. for construction of 26,000-bbl./day feed preparation unit, 12,000-bbl./day hydrotreater and 12,000-bbl./day catalytic reformer at its Lawrenceville, Ill., refinery. Late 1959 is target completion date.

Air Reduction will supply an additional 5 million cu. ft./mo. oxygen to the Kansas City, Kan., area from a new oxygen-nitrogen plant now under construction. Unit will be finished by December.

American Chemical Corp., jointly owned by Stauffer and Richfield Oil, is planning construction of a chlorinated hydrocarbons plant somewhere in southern California. Exact location and capacity are unannounced.

Wyandotte Chemicals will spend $500,000 modernizing its foundry operations at firm's North Works in Wyandotte, Mich. Foundry turns out runner bars used by glass manufacturers in grinding glass prior to final polishing.

Liquid Carbonic, division of General Dynamics, has dedicated two industrial gas plants in the San Francisco area valued at more than $2.5 million. Installation at San Carlos, Calif., will produce hydrogen; unit at Oakland will turn out oxygen, nitrogen and argon.

Stauffer engineers supplied technology and directed construction of Australia's second carbon bisulfide plant at Newcastle, N.S.W. Plant, to supply Australia's rayon industry, is a wholly-owned subsidiary of Australian Cream Tartar Co. in which Stauffer has a 34% interest.

U. S. Gypsum Co. will erect new gypsum manufacturing plant at Sperry, Iowa, to be completed in 1960. Cost and capacity not yet announced.

Kohler-McLister Paint Co. is spending $400,000 to expand production by 250% at Denver, Colo., plant. Program includes new warehouse, laboratory and revamped manufacturing facilities.

Lignosol Chemicals' plant in Quebec is undergoing a million-dollar expansion to double waste sulfite liquor capacity. Heart of expansion will be 100,000-lb./day spray drier engineered and built by Bowen Engineering of Long Branch, N. J.

Glidden Co. has established a new plastics research and development laboratory at firm's paint division research center in Cleveland. Emphasis will be on polyesters, polyurethanes and butoxy resins.

British Nylon Spinners, jointly owned by Imperial Chemical Industries and Courtalds, is planning a $28-million nylon plant near Portsmouth, Hampshire. Construction will start as soon as Board of Trade gives the go-ahead and will take about two years to complete.

Jefferson Lake Petrochemicals of Canada has made its first shipment of sulfur from the Peace River gas fields to pulp and paper mills in British Columbia. Firm operates a $2.3-million plant at Taylor, B. C., adjacent to gas processing plant of Pacific Petroleum.

Argonne National Laboratory is erecting a Fuels Technology Center at Lemont, Ill., for processing nuclear-age metals. Center is expected to enable Argonne scientists to speed up and expand efforts to find ways to use plutonium as fuel for nuclear power reactors.

Fluor Corp. will proceed with detailed engineering work on a waste calcination system for National Reactor Testing Station near Arco, Idaho, under a new $300,000 contract from the AEC. System will calcine highly radioactive

Life in these excited states...

"I've chipped off all the rust, Chief, but don't the walls seem kind of thin?"

Corrosion makes profits thin, too

If corrosion and contamination are eating into your profit margin, you need chemical-resistant equipment by American Hard Rubber Company. Look today to see where you can use Ace rubber and plastic pipe, valves, pumps, tanks and special parts. It doesn't cost... it pays!

Ace chemical-resistant rubber-lined steel pipe best for high-pressure, big sizes, or abrasives. Pipe, fittings and valves 1½ to 24".

Highly efficient *WE* pump. Capacity to 360 gpm. Cast iron, fully protected by top quality, chemical resistant hard rubber lining.

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Variety and quality to match *any* plastic piping. Riviclor PVC, Ace-Ite rubber-plastic, Parian poly, Ace Saran, Tempron high temperature nitrile, hard rubber-lined steel.

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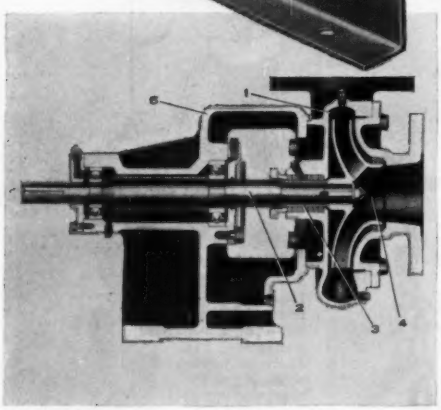

5 WAYS this Weinman Pump ends your industrial pumping problems

Here's how to lick your pumping worries fast. Weinman Type GB single stage, end suction centrifugal pumps handle all kinds of tough jobs easily, efficiently. These 5 design features tell why.

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You can get this same efficient, trouble-free performance in other Weinman pumps. Whatever your pumping requirements, chances are that a Weinman pump can give you better performance at lower cost. For information about the complete Weinman pump line, write for free bulletins. Or, call your Weinman pump specialist—he's in the Yellow Pages of your telephone directory.

See your Weinman pump specialist

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CENTRIFUGAL SPECIALISTS

liquids into a dry material that takes up much less room in underground storage vaults.

Red China announces that two more Chinese-designed, Russian-built phosphate fertilizer plants have gone on stream: One in Nanking, East China, and the other in Taiyuan, North China. Total capacity of two plants is 600,000 tons/yr., says Peking radio, adding, "In a few years, Communist China's total output of chemical fertilizer will outstrip that of Britain."

Linde Co. has just completed a 10-ton/day high-purity oxygen plant for Kimble Glass Co. in Columbus, Ohio. Use of oxygen is relatively new to glass industry but is said to contribute to lower production costs and higher quality.

Atomics International will build a $2-million remote-handling facility at its field laboratory near Los Angeles for studying radioactive materials from nuclear reactors. Installation will be part of recently announced plans to expand company's laboratory in the Burro Flat area of the Santa Susana Mountains.

NEW COMPANIES

Dixon Chemical & Research is forming a new export-import division to be called Dixon International. This division will develop firm's overseas sales and imports; offices are in Bloomfield, N. J.

Richfield Oil has organized a Petro-Chemical Dept. to direct current and future activities in the petrochemical field. Earlier this year, Richfield started up its 36-million-gal./yr. benzene-toluene unit at Wilmington, Calif. (*Chem. Eng.*, July 14, p. 169).

Vitro Corp of America has formed an Italian subsidiary,

Vitro Italiana, with offices in Rome and Milan. Activities will include design and construction of nuclear facilities, petroleum and chemical processing plants.

U. S. Rubber Co. and Rumianca Co., one of Italy's largest chemical firms, have formed an Italian company to manufacture and market chemical products of the rubber firm's Naugatuck Chemical division. New Name: Naugatuck-Rumianca, S.p.a.

Dow's new subsidiary company, Dow Agrochemicals, Ltd., will manufacture and sell agricultural chemicals in Great Britain. Headquarters of the new company are in London.

CFI Corp., Mineola, N. Y., is a new company manufacturing a wide variety of precision ceramic parts and composites. Company will concentrate on precision ceramics for electronic components, aviation and nuclear industries.

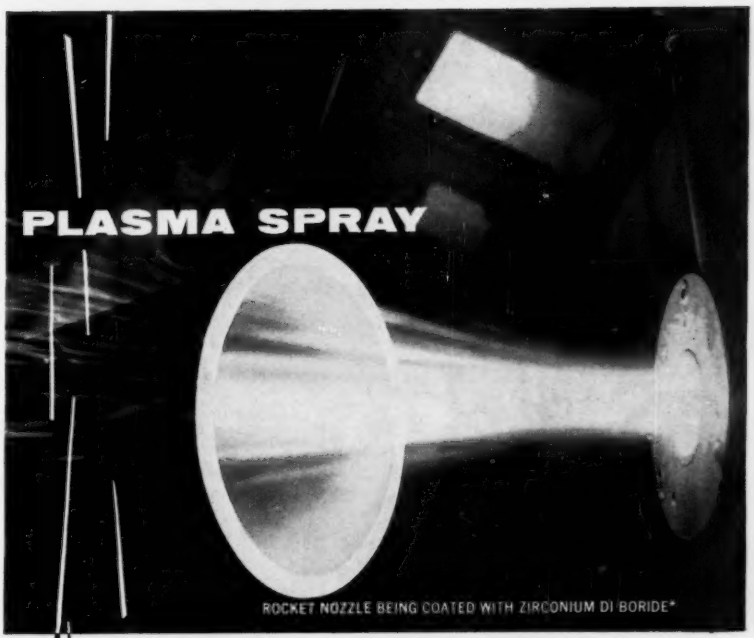
Pyrometer Co. of America will soon start manufacture of instruments, thermocouples and accessories in a new 12,000-sq.-ft. plant in Penndel, Pa., 20 mi. northeast of Philadelphia.

Ceramic - Metal Assemblies Corp., organized early this year, is now developing and producing ceramic-metal assemblies at its new plant in Latrobe, Pa.

MERGERS & ACQUISITIONS

Vick Chemical plans to acquire the Lavoris Co., manufacturer of proprietary mouthwashes. Agreement must be ratified by Lavoris stockholders.

Yuba Consolidated Industries has purchased Western Rolling Mills of San Jose, Calif.,



revolutionary new coating technique

Man's major problem in his use of energy has always been materials. As we advance into more complex technologies the need for a more practical method of working with high temperature and high stress materials has become compelling. Now, Plasma Spray, a radically new device capable of vaporizing and propelling any element or combination of elements, offers the materials engineer new horizons in the design of coating compositions and properties.

This new tool extends the range and capabilities of materials processing into refractory metals, carbides, borides, silicides and nitrides. With Plasma Spray practically any material can be spray coated on another.

The Plasma Spray system consists of a standard Plasmatron head fitted with a concentric spray attachment. With its inert jet of intense heat and controlled temperatures to 15,000°F, the instrument can vaporize, spray and coat even the most reactive and refractory of materials. Plasma Spray utilizes the assemblage of electrically neutral, partially ionized gas with an electric arc created by the Plasmatron. Obtaining heat from a constricted and sustained discharge, plasma temperatures are three to five times that of an oxyacetylene flame, and the inert jet offers a completely uncontaminated spraying environment which does not oxidize either the base or the sprayed material.

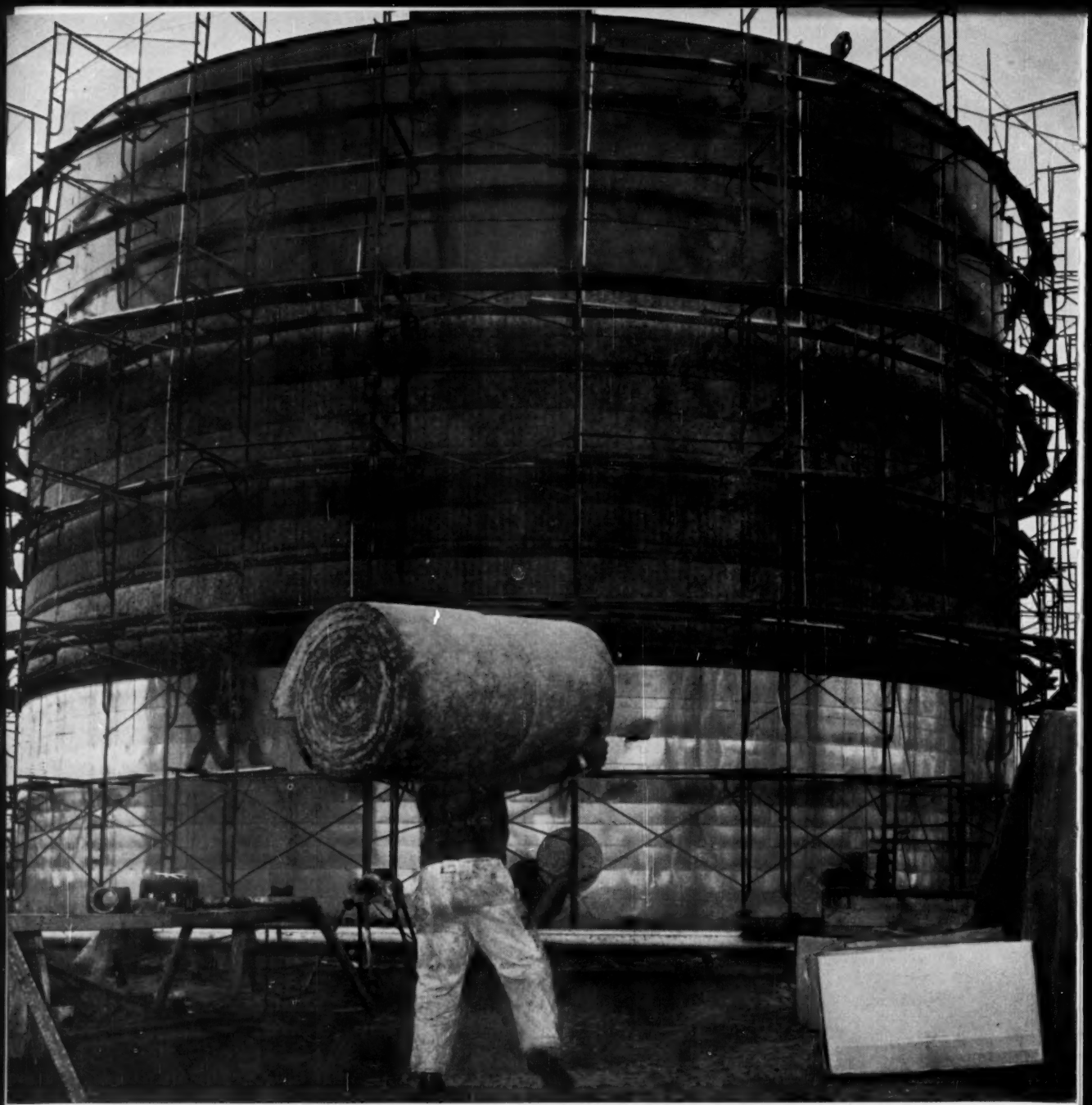
Plasma Spray places in the engineer's hands an infinite number of combinations of physical properties and coating compositions for more practical solutions of high temperature, high stress materials requirements.

**ZrB2 coating illustrated above is from 90-95% of theoretical density being sprayed at 15,000°F. Melting point of ZrB2 is 5500°F. Microhardness of coating is 2000 Kilograms per mm. under 50 gram load.*

Write for price and delivery.

Giannini plasmadyne Corporation

3839 South Main Street, Santa Ana, California



He's carrying enough ULTRALITE to insulate 600 sq. ft. of tank!

. . . and in short order, that 600 sq. ft. roll of ULTRALITE glass fiber insulation will be permanently in place on the tank. Resilient ULTRALITE simply *wraps around* tanks, vats and vessels . . . takes only a fraction of the time required by the bat-at-a-time method. ULTRALITE "hugs" tanks closely, eliminating cracks and fluing action, and its K factor is only .27 at 70° mean temperature.

It all adds up to this: with ULTRALITE you can do a "deluxe" job—including metal weatherproofing sheets—*at no extra cost!* For details, write direct or—

CALL YOUR G-B INSULATION DISTRIBUTOR (LISTED IN ADJOINING COLUMN)

GUSTIN-BACON *Manufacturing Company*

252 W. 10th St., Kansas City, Mo.

Thermal and acoustical glass fiber insulations • Pipe couplings and fittings • Molded glass fiber pipe insulation

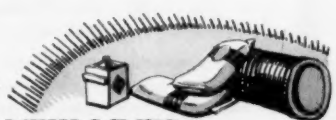
for undisclosed amount of cash. Western's steel-making and steel-rolling facilities will be enlarged, modernized and moved to a 140-acre site near Phoenix, Ariz.

Rexall Drug Co. recently purchased Chemtrol Co. of Lynwood, Calif., manufacturer of plastic valves. Valves will complement plastic pipe and fittings made by Kraloy Plastic Pipe Co., another Rexall subsidiary.

Cooper-Bessemer has acquired Creole Engineering of Houston, Tex., as a new wholly owned manufacturing and engineering subsidiary. Firm will concentrate on packaged, pre-piped gas engine compressors.

Chase Bag Co. is enlarging its position in the plastic film field through acquisition of all polyethylene film extruding machinery and processes of Plax Corp., Hartford, Conn. With added facilities, Chase will produce wide range of polyethylene tubing and sheet.

Flintkote and Hankins Container Co. have drawn up plans to merge the latter firm into Flintkote, subject to approval of stockholders of two companies. Hankins, with headquarters in Cleveland, has string of six corrugated container plants throughout eastern U. S.



NEW LINES

American Felt Co. has formed a new technical sales division to promote its Windsor fiber-welded filter media. Windsor fabrics eliminate need for secondary dressing materials in many filtering applications.

Hanson-Van Winkle-Munning Co. is expanding its rectifier department to develop equipment for electrochemical and

G-B ULTRALITE DISTRIBUTORS

(See ad on facing page)

ALBUQUERQUE, Mt. States Insulation Co.
AMARILLO, Ball Distributing & Engr. Co.
ATLANTA, Ga., Reynolds Aluminum Supply Co.
BALTIMORE, Md., Leroy Insulation Co.
BILLINGS, Mont., Big Horn Supply, Inc.
BIRMINGHAM, Ala., Shook & Fletcher Supply
Reynolds Aluminum Supply Co.
BOSTON, Mass., Homans-Kohler, Inc.
BROOKLINE, Mass., Homans-Kohler, Inc.
BUFFALO, Industrial Insulation Sales, Inc.
CHARLESTON, W. Va., Baldwin Asbestos Products Co.
CHARLESTON HEIGHTS, S. C., Stafford Insulation Co.
CHARLOTTE, N. C., Guy M. Beaty & Co.
CHATTANOOGA, Guy M. Beaty & Co.
CHICAGO, E. C. Carlson Co.
CINCINNATI, R. E. Kramig & Co.
CLEVELAND, The Miles Materials Co.
COLUMBUS, Santeler Brothers
CORPUS CHRISTI, Texas, Precision Insulation Co.
DALLAS, Insulation Supply Co.
Payne-Ladewig, Inc.
DAVENPORT, Republic Electric Co.
DENVER, Gene Wright Lumber Co.
DES MOINES, Iowa Asbestos Co.
DETROIT, Coon DeVisser Co.
EL PASO, Insulation & Specialties Co.
EVANSVILLE, Ind., George Koch Sons, Inc.
FARGO, N. D., Smith, Inc.
FT. SMITH, Ark., Gunn Distributing Co.
FT. WAYNE, Ind., M. H. Hilt, Inc.
FT. WORTH, The Bracken Co.
GREENSBORO, N. C., Starr Davis Co., Inc.
GULFPORT, Miss., Paine Supply Co.
HOUSTON, Precision Insulation Co.
INDIANAPOLIS, Central Supply Co.
IRON MOUNTAIN, Mich., Champion, Inc.
JACKSONVILLE, Ferber Sheet Metal Works
JACKSON, Miss., Paine Refrigeration & Supply Co.
JOPLIN, Mo., Joplin Cement Co.
KANSAS CITY, Kelley Asbestos Co.
LITTLE ROCK, Gunn Distributing Co.
LOS ANGELES, Western Fibrous Glass Products
Thorpe Insulation Co.
LOUISVILLE, General Insulation & Roofing Co.
MEMPHIS, John A. Denie's Sons Co.
MIAMI, Crabtree Insulation Co.
Reynolds Aluminum Supply Co.
MILWAUKEE, F. R. Dengel Co.
MINNEAPOLIS, Asbestos Products, Inc.
MOBILE, Ala., Shook & Fletcher, Inc.
NASHVILLE, Reynolds Aluminum Supply Co.
NEWARK, N. J., Eastern Steam Specialty Co.
NEW HAVEN, Conn., Insulation Supply Co.
NEW ORLEANS, Eagle Asbestos & Packing
NEW YORK, Eastern Steam Specialty Co.
OKLAHOMA CITY, Ball Distributing & Engineering Co.
OMAHA, Cardinal Supply & Mfg. Co.
PHILADELPHIA, John F. Scanlan, Inc.
PITTSBURGH, Dravo Corp.
PHOENIX, Ariz., Kircher Asbestos & Rubber Co.
RALEIGH, N. C., Reynolds Aluminum Supply Co.
RAPID CITY, S. D., Robbins & Stearns Wholesale
RICHMOND, Va., Reynolds Aluminum Supply Co.
ROCKFORD, Ill., Mott Brothers Co.
SALT LAKE CITY, Bullough Asbestos Supply Co.
SAN ANTONIO, The Bracken Co.
SAN DIEGO, Western Fibrous Glass Products
SAN FRANCISCO, Western Fibrous Glass Products
SAVANNAH, Ga., Reynolds Aluminum Supply Co.
SEATTLE, Western Fibrous Glass Products
ST. LOUIS, The Stovey Company, Inc.
ST. PAUL, Asbestos Products, Inc.
SYRACUSE, N. Y., Industrial Supply Co.
SULLIVAN, Ill., Lewi David, Inc.
TAMPA, Fla., Eagle Roofing & Art Metal Works, Inc.
TALLAHASSEE, Fla., Bakers, Inc.
TULSA, Okla., Ball Distributing & Engr. Co.
TUPELO, Miss., Paine Supply Co.
WASHINGTON, D. C., Walter E. Campbell Co., Inc.
WICHITA, General Metals, Inc.
VANCOUVER, B. C., Fleck Brothers Limited

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Key TO TOP QUALITY and SERVICE

Catalog A-7
FOR COMPLETE INFORMATION

MAC-IRON
BLINDS, SPACER RINGS, TEMPORARY STRAINERS, LINE STRAINERS, and PIVOT FLANGES • • •

This comprehensive booklet is your guide to the use of specialized equipment planned and produced to function with extreme efficiency. Detailed specifications, descriptions, and data are included.

In the years of supplying to the Petro-Chemical Field MAC-IRON has developed a design and production service to a degree seldom equalled. *If confronted with an emergency or tight schedule, PHONE US.* If not in stock, the equipment you need will be made up at once.

Your inquiry will promptly bring a copy of Catalog A-7 or specific engineering data. PHONE MAin 6-3712 FOR IMMEDIATE PRODUCTION OR CONSULTATION SERVICE.

"IF YOU USE PUMPS
You need MAC-IRON Strainers"

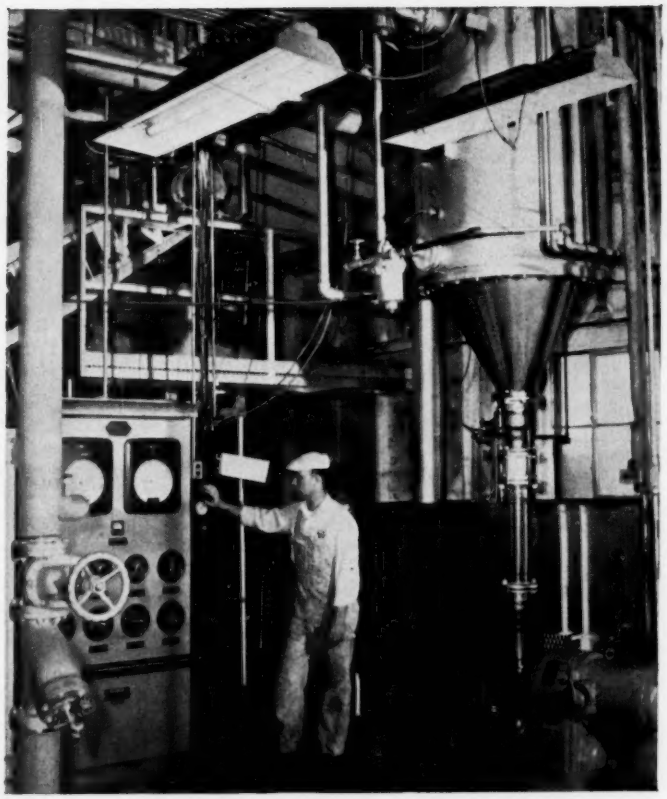
SANDUSKY MAC-IRON OHIO
ESTABLISHED 1901
The MACK IRON WORKS COMPANY
132 WARREN ST.

Del Monte FOOD PRODUCTS

superior quality at

5 tons per hour

with the



RODNEY HUNT

Turba-Film® Processor

TO SOLVE YOUR PROCESS PROBLEMS...

Rodney Hunt welcomes specific requests for help in solving process problems involving mechanically aided heat and mass transfer, for product testing and for evaluation of processing techniques. Our fully equipped laboratory and pilot plant is staffed by engineers and technicians with wide experience across the entire range of thin-film processing, from one-half micron to atmospheric pressures.

For those who prefer to do their own testing and research, portable laboratory-size Turba-Film and Vacu-Film Processors are available for purchase or rental. With these units, thin-film processing techniques can be properly evaluated. Test results obtained from pilot-size Vacu-Film and Turba-Film Processors can be readily extrapolated to production-size units.

Please address your inquiries to the Process Equipment Division.

The Del Monte label has long meant superior quality in canned and processed foods. In producing Del Monte fruit concentrates, the California Packing Corporation uses a Rodney Hunt Turba-Film Processor to assure desired quality and character—a thick paste with fine flavor and good color.

Operating 24 hours a day during the peak season, this Turba-Film Processor maintains an excellent operating record with a minimum of maintenance. Pears and apricots are processed to a concentration of about 2.5 to 1 at a rate of 5 tons per hour—tomatoes to a concentration of about 3.5 to 1 at 3 tons per hour. And the equipment is readily variable to meet the different heating temperatures and operating pressures required for each product.

The taste and quality of the concentrate is protected from the injurious effects of overheating because of the precisely controlled, short-time exposure of the product in the thermal section. This is one of the most important advantages of the Rodney Hunt Turba-Film Processor—an advantage that has been widely applied throughout the process industries. Whether for chemicals, petroleum residues, pharmaceuticals and other temperature-sensitive products, the Turba-Film Processor will consistently and automatically retain the essential properties and desired qualities of the product being processed.

RODNEY HUNT MACHINE CO.

PROCESS EQUIPMENT DIVISION 31 VALE ST., ORANGE, MASS.

RODNEY HUNT

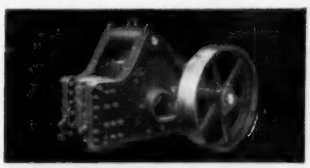
SERVING THE PROCESS INDUSTRIES WITH EQUIPMENT AND ENGINEERING

NO MAJOR REPAIRS IN 25 YEARS*

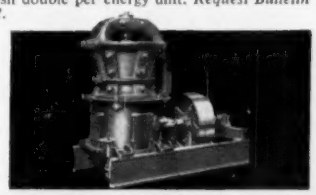
Sturtevant Construction Assures Long Mill Life at Top Loads

Sturtevant crushing and grinding machinery answers the long life top-load production problem for medium to small size plants. Many Sturtevants have been operating above rated capacities for more than 25 years, and *without a major repair.*

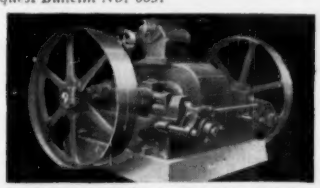
"Open-Door" design gives instant accessibility where needed — makes cleanouts, inspection and maintenance fast and easy. Machines may be set up in units to operate at equal quality and capacity.



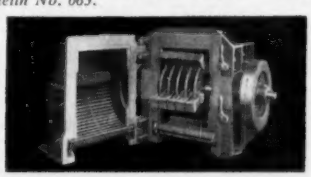
Jaw Crushers — Produce coarse (5 in. largest model) to fine (⅛ in. smallest model). Eight models range from 2 x 6 in. jaw opening (lab model) to 12 x 26 in. Capacities to 30 tph. All except two smallest sizes operate on double cam principle — crush double per energy unit. *Request Bulletin No. 062.*



Rotary Fine Crusher — Reduce soft to medium hard 3 to 8 in. material down to ¼ to 1¼ in. sizes. Capacities up to 30 tph. Smallest model has 6 x 18 in. hopper opening; largest, 10 x 30 in. Non-clogging operation. Single handwheel regulates size. *Request Bulletin No. 063.*



Crushing Rolls — Reduce soft to hard 2 in. and smaller materials to from 12 to 20 mesh with minimum fines. Eight sizes, with rolls from 8 x 5 in. to 38 x 20 in.; rates to 87 tph. Three types — Balanced Rolls; Plain Balanced Rolls; Laboratory Rolls — all may be adjusted in operation. *Request Bulletin No. 065.*



Hammer Mills — Reduce to 20 mesh. Swing-Sledge Mills crush or shred medium hard material up to 70 tph. Hinged-Hammer Pulverizers crush or shred softer material at rates up to 30 tph. Four Swing-Sledge Mills with feed openings from 6 x 5 in. to 20 x 30½ in. Four Hinged-Hammer Pulverizers with feed openings from 12 x 12 in. to 12½ x 24 in. *Request Bulletin No. 084.*

**Reports Manager W. Carleton Merrill concerning Sturtevant Swing-Sledge Mill at James F. Morse Co., Boston.*

STURTEVANT
MILL COMPANY
100 Clayton St., Boston 22, Mass.

FIRMS . . .

electrometallurgical processing, utility power conversion and other industrial d.c. applications. Firm now specializes in low-voltage rectifiers for electroplating industry.

NEW REPRESENTATIVES

Gulf Oil Corp. has licensed Artisan Metal Products of Waltham, Mass., to sell Gulf-designed pilot plants. Artisan will fabricate and market Gulf's midget fluid catalytic cracking pilot plant and equilibrium flash vaporizer.

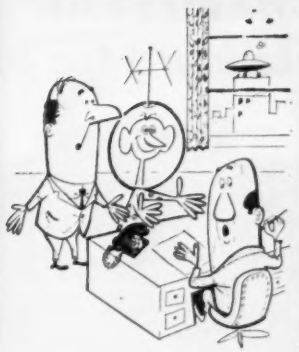
Foote Mineral Co. has been appointed exclusive U.S. and Canadian sales agent for nickel and cobalt produced by Sherritt Gordon Mines, Ltd., Toronto.

Hooker Chemical announces the name "Phosphorus Div." for the four plants formerly operated by Shea Chemical. Plants are located at Adams, Mass.; Columbia, Tenn.; Jeffersonville, Ind.; and Dallas, Tex.

Gulton Industries, Metuchen, N. J., is changing the name of its Glennite Instrumentation Div. to the Gulton Instrumentation Div.

Askania Regulator Co., subsidiary of General Precision Equipment Corp., is changing its name to GPE Controls, Inc.

Crouse-Hinds Instrument Co., Silver Spring, Md., is name of firm formerly known as Surveyor Service Co. Firm has been wholly owned subsidiary of Crouse-Hinds Co. since 1956.



"I didn't catch where he's from, but he wants to place an order for *Mallinckrodt Industrial Chemicals.*"

Seriously speaking . . .

This hasn't happened yet, but we do have some "firsts" in the Atomic Age! **Mallinckrodt refined all of the uranium used in the first self-sustaining nuclear reaction.** Now, in our new privately-financed uranium processing plant, we are the first to produce **commercial uranium fuel materials** for use in power and research reactors.

This same technical know-how, which has made Mallinckrodt a major contributor to nuclear progress, has been solving many other chemical processing problems for years. Over 200 industries have learned to depend upon Mallinckrodt for tonnage quantities of uniform chemicals — controlled for purity and physical form.

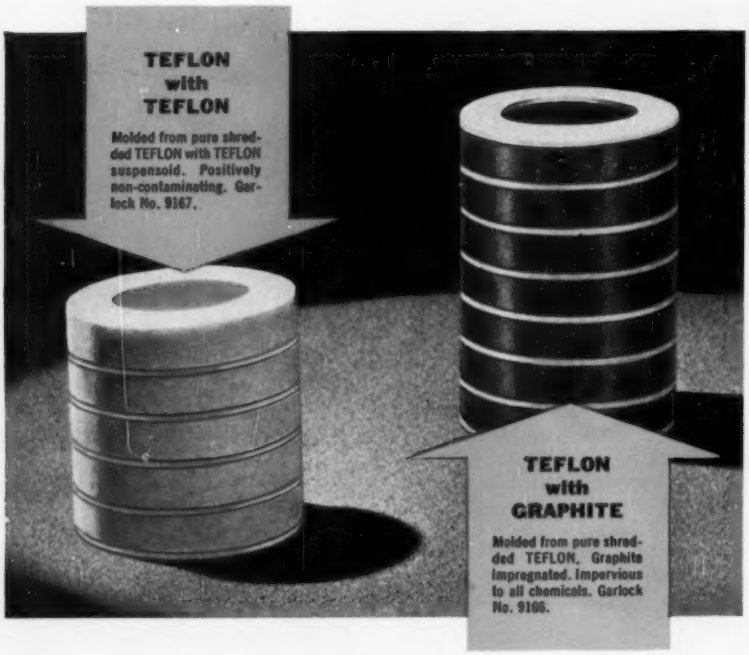
Contact Mallinckrodt for your process chemical requirements. A sales office is in your area.

Remember . . . you might be better served by Mallinckrodt

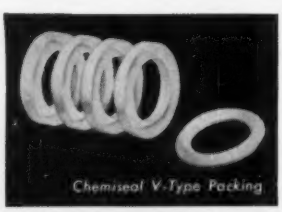
Mallinckrodt®

MALLINCKRODT CHEMICAL WORKS
ST. LOUIS • NEW YORK • MONTREAL

CHEMISEAL® PUMP PACKINGS
standard for corrosion service . .


TEFLON with TEFLON
Molded from pure shredded TEFLON with TEFLON suspensoid. Positively non-contaminating. Garlock No. 9167.
TEFLON with GRAPHITE
Molded from pure shredded TEFLON, Graphite impregnated. Impervious to all chemicals. Garlock No. 9166.

. . good for all chemicals



FOR VALVES

Solid TEFLON Ring packings are available in Chemiseal V-type, diagonal, triangular, conical and Garlock Chevron† ring designs—providing necessary seal at low gland pressure and reducing torque required to operate the valve.

Chemiseal TEFLON* Pump packings offer remarkably trouble-free service, and useful life many times that of other type packings.

Impervious to all chemicals, excepting only molten alkali metals and fluorine at elevated temperatures, these packings are giving highly satisfactory performance sealing against such difficult and hazardous liquids as sulphuric, chromic, nitric and hydrofluoric acids; chlorine, bromine, sulphur chloride, sulphur oxychloride, hydrogen fluoride and concentrated hydrogen peroxide.

Extremely effective for rotating and reciprocating shafts, Chemiseal TEFLON pump packings provide a low friction, 2-way seal that not only prevents axial seepage, but also seals against shaft and stuffing box as well. Supplied in sets to meet specific requirements.

For prompt service, contact one of The Garlock Packing Company's 30 sales offices and warehouses in the U.S. and Canada, or write for Bulletin AD-155.

®U.S.G. Trademark
*du Pont Trademark
†Garlock Trademark

United States Gasket Company
Camden 1, New Jersey

United States Gasket Plastics Division of **GARLOCK**

CALENDAR

Technical Assn. of the Pulp and Paper Industry, 12th Alkaline Pulping Conference, Arlington Hotel.
Sept. 24-26 Hot Springs, Ark.

Chemical Market Research Assn., market research conference, French Lick Sheraton Hotel.
Sept. 24-26 French Lick, Ind.

American Institute of Chemists, New York Chapter, topic: "The Best Job for You", Chemists Club.
Sept. 25 New York, N. Y.

The Electrochemical Society, 114th meeting, Chateau Laurier.
Sept. 28-Oct. 22 Ottawa, Canada

American Society of Mechanical Engineers-American Institute of Electrical Engineers, National Power Conference, Statler-Hilton Hotel.
Sept. 29-Oct. 1 Boston, Mass.

Oak Ridge National Laboratory, conference: Analytical Chemistry in Nuclear Reactor Technology.
Sept. 29-Oct. 1 Gatlinburg, Tenn.

Technical Assn. of the Pulp and Paper Industry, 9th Paper Testing Conference, Oglethorpe Hotel.
Sept. 30-Oct. 2 Savannah, Ga.

Society of Plastics Engineers, New England Section, regional technical conference, Statler-Hilton Hotel.
Oct. 1 Hartford, Conn.

American Institute of Chemical Engineers, South Texas Section, 13th annual technical meeting, Moody Center.
Oct. 3 Galveston, Texas

American Society for Quality Control, 2nd annual Chemical Division conference, Statler-Hilton Hotel.
Oct. 2-3 Buffalo, N. Y.

National Assn. of Corrosion Engineers, Northeast Region, regional conference.
Oct. 6-8 Boston, Mass.

American Society of Mechanical Engineers-American Society of Lubrication Engineers, Lubrication Conference, Statler Hotel.
Oct. 13-15 Los Angeles, Calif.

Packaging Institute, 20th annual forum, Edgewater Beach Hotel.
Oct. 13-15 Chicago, Ill.

Society of Industrial Packaging and Materials Handling Engineers, annual national exposition, Coliseum.
Oct. 14-16 Chicago, Ill.

Second Energy Resources Conference, Brown Palace Hotel.
Oct. 15-17 Denver, Colorado

American Oil Chemists Society, fall meeting, Sherman Hotel.
Oct. 20-22 Chicago, Ill.

American Institute of Chemical Engineers, New York Section; all day symposium: Cost Engineering, Foams and Froths, Petroleum Chemicals, Hotel Statler.
Oct. 23 New York, N. Y.

3 NEW METHODS OF BULK HANDLING

SUPERIOR AIR CONVEYING REALLY CUTS COSTS

1. Air unload powder or granular material efficiently with the new Superior "CYCLO-VAC".
2. Convey material anywhere through sanitary pipelines with a Superior "FLUIDIZER".
3. Switch lines instantly, "on stream" with the new Superior flow diverter.

Superior . . . most advanced in modern air handling

PROCESS MACHINERY DIVISION

Product Sales or Systems Engineering

Superior

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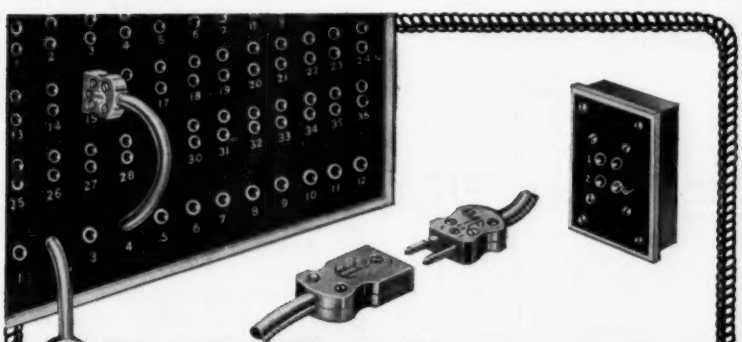


Transfer Many Thermocouples

With T-E Quick-Coupling Connectors and Panels

Connector Panels T-E has one for your exact needs. These panels provide flexible, centralized control in transferring any number of thermocouples to indicating, multi-point recording and controlling pyrometers. Ideal for patch panel use, they are available in many compact shapes and sizes — with interchangeable plugs and jacks in I-C, C-C, and C-A. A panel for 48 thermocouples and 16 pyrometers measures only 13¼" x 7⅞". Polarity markings and screw-fastened connections make wiring easy.

Quick-Coupling Connectors These connectors permit fast, easy making and breaking of thermocouple circuits. Durable construction guarantees long, dependable usage. Polarized and mechanically interchangeable, all plugs and jacks are of standard matched thermocouple materials. Spring-loaded contacts with long wiping surfaces provide firm but easily broken connections.

Write for Bulletin 23 — E

Thermo Electric Co., Inc.
SADDLE BROOK, NEW JERSEY
In Canada — THERMO ELECTRIC (Canada) Ltd., Brampton, Ont.

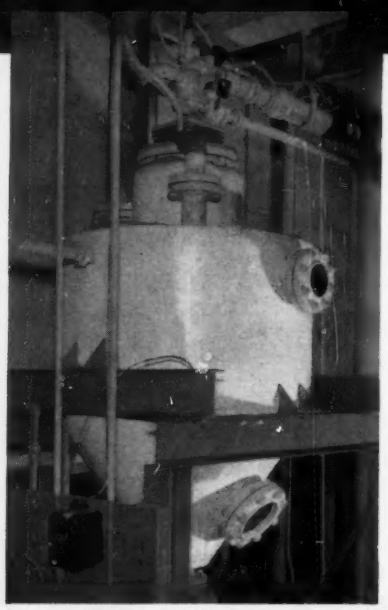
DEFIES HEAT ABRASION... FATIGUE... LEAKS

FLEXIBLE TUBING FOR INDUSTRY

High temperatures and pressures? Exposure to crushing, abrasion, expansion, contraction? Name your operating conditions for air, water, steam lines, for conveying volatiles, gases, chemicals, powder, granular and semi-solid materials. Penflex can meet them with flexible bronze, galvanized and stainless steel corrugated and interlocked tubing. All types, all sizes. ⅛" to 24" I. D. Ask for booklet. Pennsylvania Flexible Metallic Tubing Company, Inc. 7234 Powers Lane, Phila. 42.

PENFLEX
TIGHT AS A PIPE BUT... FLEXIBLE

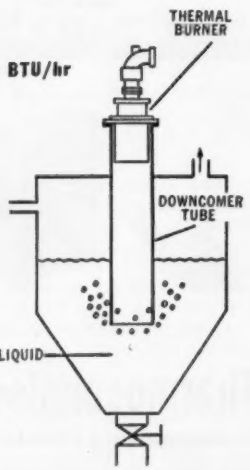
THERMAL
SUBMERGED
COMBUSTION



simplicity of design and construction... *plus* extreme compactness

HEAT INPUTS OF 250,000 BTU/hr to 5,000,000 BTU/hr

The high heat release rate of the THERMAL High Velocity burner used in these submerged combustion installations allows the use of a simple downcomer tube through which the products of combustion are discharged beneath the surface of the liquid. This arrangement is possible because combustion is 90% completed within the burner proper. The THERMAL burner is completely separate from the liquid being heated and maintenance, control and accessibility are greatly simplified. Equally simple arrangements are possible with gas, oil or combination fuel.



BROAD RANGE OF APPLICATIONS

Depending upon the material being heated either a metal or refractory downcomer tube may be used. Some of the more common applications are pickling baths, acid concentration, caustic soda concentration, aluminum sulphate concentration, water recarbonization, and glass frit and molten salt heating.

WRITE FOR BULLETIN 115

OTHER THERMAL PRODUCTS & SERVICES → Gas, Oil & Combination Burners • Air Heaters • Combustion & Heat Transfer Equipment

THERMAL
Thermal Research & Engineering Corp.
CONSHOHOCKEN • PENNSYLVANIA
REPRESENTATIVES IN PRINCIPAL CITIES

(Continued from p. 98)

without friction, the measuring mechanism outside the meter. Available in capacities to 22 Imp. gpm., the unit also comes with accessories such as flow transmitter or integral-action ratio controller.—**T. E. A., Inc., Flushing, N. Y.** 98A

Urethane Insulation

Snaps on. Is lightweight, crushproof, easy to apply.

Ideal for all refrigeration work and low-pressure steam lines (−200 to 250 F.), a new preformed urethane thermal insulation offers many advantages. It doesn't crumble, fray or break in handling. Water and many other liquids cause no disintegration. Low in density (3 lb./cu. ft.), it adds little additional weight to pipelines. And it is non-toxic and non-corrosive.

Urethane insulation (k of 0.29 at 75 F.) comes in standard "snap-on" pipe sleeves, and also as flat blankets of various thicknesses. Normally supplied with factory-applied vapor barrier. —**National Aniline Div., Allied Chemical Corp., New York.** 202A

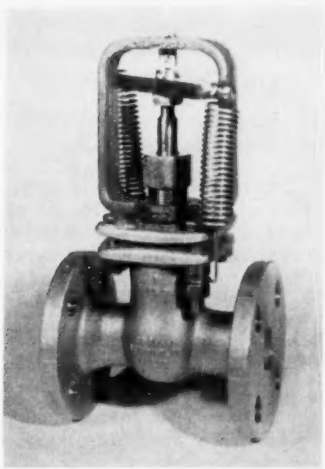
Overload Switch

Stops electric motors during the critical peak.

According to the manufacturer, a new, fast-acting, electrical control device is the first one able to stop an overloaded motor during the critical peak or starting load period. Designed to respond instantly to all momentary overloads, the

safe-load relay also protects against excessive currents after the motor is running smoothly.

Action of the new relay, controlled by a second or "limiting" pointer, does not interfere with the conventional pointer's movements across the unit's dial face. A guard-protected button sets the current-controlling pointer at any current value desired. Another button permits quick resetting.—**Baker Perkins Inc., Saginaw, Mich.** 202B



Fire Gate Valve

Foolproof unit stops flow in event of fire.

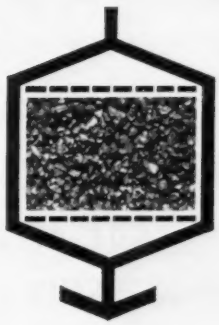
Simplicity is the key to a new fire protection cut-off valve recently introduced. Requiring neither a complex system of counterweights nor interior bellows, the stainless steel unit is essentially a modified bolted-bonnet gate valve held open against two exterior springs by a small fusible link.

Springs snap the valve shut when the fusible link reaches its melting point of 160 F., thus preventing the flow of liquid to fire areas. According to the manufacturer, virtually nothing can go wrong with the unit internally. And it can be installed in any position in cramped or highly inaccessible plant locations.

Competitive in price with similar equipment of carbon steel, the valve comes in alloy types 304, 316, FA-20 and

ACTIVATED CARBON

purifies liquids and gases; eliminates tastes, odors, chlorine, and a wide range of contaminants from liquids and solutions. Decolorizes and deodorizes liquids. Raises the standards of purity for many industrial gases. Removes undesirable impurities. Permits recovery, re-use, or resale of by-product gases. Effective for difficult gas separations. Save on heating and cooling by recirculating air through activated carbon filters. Improve comfort and safety in living and working spaces.



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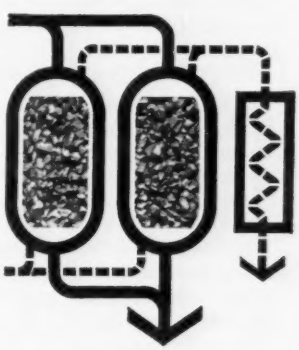
recovers solvents at a fraction of the original cost. Activated carbon adsorbs solvents from air. Helps improve products by making the best solvents economical to use. We engineer and build complete solvent recovery systems in addition to supplying bulk activated carbon. Stops pollution, removes contaminants from exhaust air or liquid effluent. Recovers by-products.



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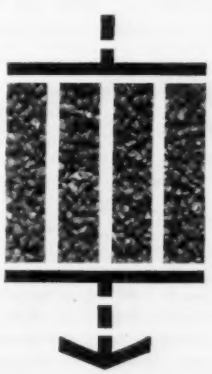
catalyzes and serves as a catalyst support. Speeds oxidation-reduction reactions, chlorinations, and hydrogenations—the key to vinyl chloride production. We supply all grades of activated carbons made to strict quality standards and provide prompt regeneration service. Barnebey-Cheney, Columbus 19, Ohio.

Write for Literature Group J-46.



Barnebey Cheney

Fansteel

Corrosionomics

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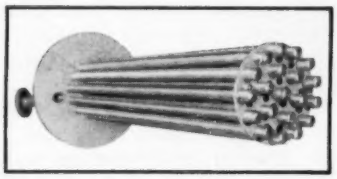
A JOURNAL OF USEFUL INFORMATION FOR THE SOLUTION OF CORROSION PROBLEMS

TANTALUM BAYONET HEATERS CUT ACID PROCESSING COSTS



Fansteel tantalum bayonet heaters come in a wide variety of sizes and shapes to fit the most critical need.

Tantalum bayonet heaters are the most economical heating units obtainable for extremely corrosive acid solutions (except hydrofluoric and fuming sulfuric). This can be proved on a cost reduction basis if all the factors of highly corrosive service are carefully considered.

Acid Proof—Long Life

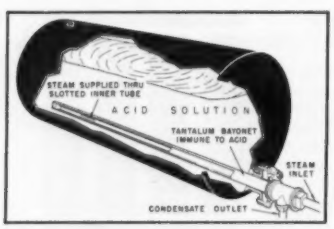
Fansteel tantalum bayonet heaters are ideally suited to acid processing requirements for several reasons. First, the pure metal is not subject to thermal shock. It is acidproof, not just acid-resistant—which makes product contamination impossible. Fansteel tantalum also has high tensile strength, compressibility, impact strength and ductility. Since no corrosion allowance need be made, only the thickness required for structural strength need be used.

High Processing Rates

Acid processing rates are very high with Fansteel tantalum heaters. The special design permits rapid removal of condensate on the steam side, promotes high velocities of both steam and condensate, and keeps the condensate film at minimum thickness. The heaters are never flooded and air can be discharged readily with the condensate. Added to this is tantalum's high rate of heat transfer which further speeds processing. Overall coefficients of 500 to 1200 are commonly obtained.

Overall Economy

These characteristics combine to make tantalum the ideal material for use in critical pieces of equipment such as heaters. The initial cost is more than justified by long, trouble-free service, simplicity of design made possible in associated equipment, and even upgrading equipment with heaters made from other materials. Heating capacities and standard sizes of Fansteel single-tube, bayonet heaters are shown in our Bulletin 3.506. They are also listed in the Chemical Engineering Catalog, page 750.



For vessels with side or bottom openings, the bayonet heater is an effective unit (single or multiple tube). Steam enters through the inner steel pipe, escapes through slots near the end and heats the tantalum tube.

Free Tantalum Test Kit

A corrosion test kit, available without charge to research technicians, if requested on your letterhead; contains both tantalum sheet and wire.

Free Technical Information

The above condensation is typical of the articles which appear in CORROSIONOMICS, a Fansteel publication. Mail us your name for inclusion on our free mailing list.

G581A

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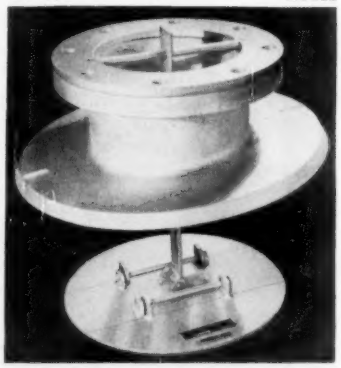
For further data on the above, write:

FANSTEEL METALLURGICAL CORPORATION
CHEMICAL EQUIPMENT DIVISION
NORTH CHICAGO, ILLINOIS, U. S. A.

nickel. Sizes from ½ to 2 in.—**Cooper Alloy Corp., Hillside, N. J.** 203A



Vapor Conserver

Claimed to cut tank vapor losses by 24-50%.

Placed beneath the vent-pipe inlet of volatile-liquid storage tanks, a new mechanical device known as the Air Baffle tends to change the flow direction of entering air from vertical to horizontal. This action minimizes vapor movements provoked by downward air velocities. It also promotes stratification within the tank's vapor space—a layer of fresh air above the layer of heavier vapors.

Air Baffle consists of a flat, horizontal plate mounted below, and in alignment with the vent pipe inlet. Collapsible design permits insertion through the inlet for quick installation.—**Shand and Jurs Co., Berkeley, Calif.** 204A

Jaw Crusher

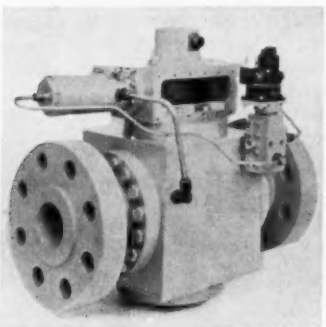
Boasts several beneficial design characteristics.

Termed the "2036," a new jaw crusher in the popular 20 x 36-in. size offers overhead eccentric construction—the moving jaw hangs from a shaft that also serves as the pitman. This arrangement eliminates double toggles, extra shafts and excess crusher weight.

Also, for an improved angle of nip to reduce belching, the crusher has a longer jaw than former models. The base features all welded-steel, double-

wall construction, on which the bearings are saddle-mounted to prevent weave and wobble.

Hydraulically adjustable, the unit has a rated capacity under average crushing of 190-200 tons/hr. of 6-in. minus product. Rated capacity of 3-in. minus product is 95-100 tons/hr.—**Pioneer Engineering, Minneapolis, Minn.** 204B



Safety Ball Valve

Features extremely fast full-stroke operation.

While working against pressures to 4,000 psi. and temperatures to 250 F., a new ball valve can fully open or close a 3-in. line in only 0.007 sec. A built-in accumulator, which is controlled by an integral explosive-squib pilot valve, stores the unit's supply of high-pressure air.

When actuated by electrical signal, the squib explodes, thus opening the accumulator and releasing the air. The air, in turn, operates the cylinder piston that rotates the ball.

A motor-operated selector valve simplifies accumulator recharging operations. Materials of construction make the entire unit suitable for use with most liquids or gases.—**Hydromatics, Inc., Livingston, N. J.** 205A

Radiometer

Measures temperature distribution along fibers.

Sensitivity and short response time of a new radiometer enable accurate measurement of the temperature distribution along fibers during high-speed

JOHN CRANE'S line of Chemlon Packing offers an unlimited selection of types, shapes and sizes for practically every service requirement:

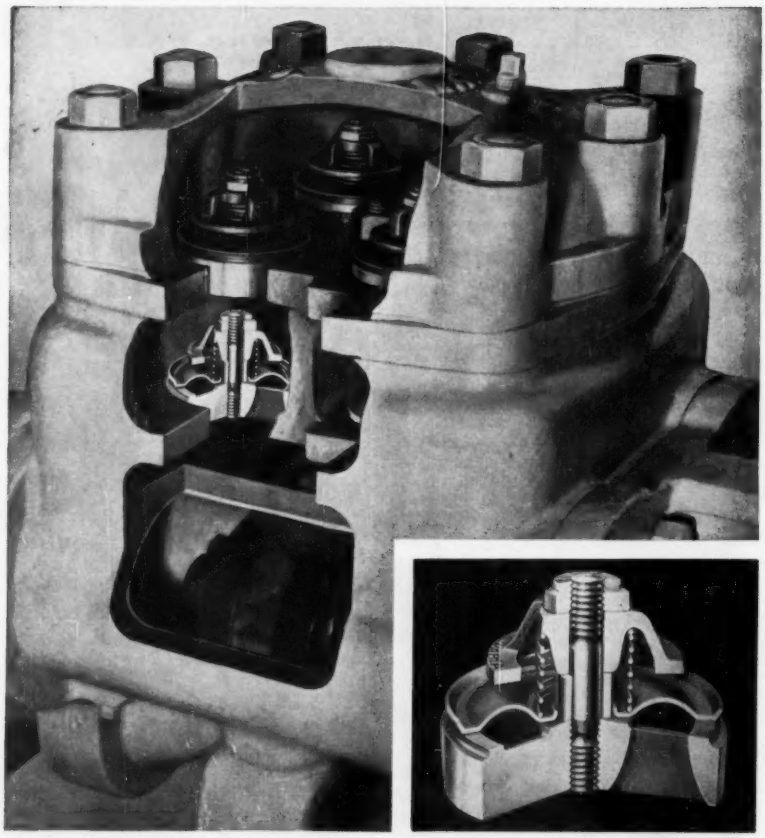
. . . . . types best suited for valves and automatic regulators.

. . . . . for high or low-speed centrifugal, rotary or reciprocating pumps.

. . . . . for agitators and mixers.

Here in one bulletin is illustrated and described industry's most complete line of chemically inert packings. You'll save time, trouble and expense on fluid or gas handling problems by requesting Bulletin P-325.

Crane Packing Company, 6451 Oakton Street, Morton Grove, Illinois (Chicago Suburb). *In Canada: Crane Packing Co., Ltd., Hamilton, Ont.*



The valve for reciprocating pumps . . . old or new

Because they offer a happy combination of dependability, efficiency and extra life, DURABLA Valves are a credit to any reciprocating pump. Mechanically and metallurgically speaking, they will operate freely under temperature-pressure extremes, with highly corrosive fluids and in any position.

In a DURABLA Valve Unit, only "point contact" is made by the valve member on the sleeve, so it can't bind or hang-up. Due to its unique arched design, neither will it warp. The new V-7* taper-locked stud can be screwed down tight into the seat without any possibility of galling or breakage. And a self-locking nut and "drop-on" guard assure quick and easy inspection of working parts —without stud or seat removal.

Standard equipment on many new pumps, DURABLA Valve Units are also used throughout the world to re-valve older pumps. They come in fifteen sizes, designed to meet over 300 variations in installation requirements.

Write for new booklet CE-98

DURABLA MANUFACTURING COMPANY
114 Liberty Street, New York 6, New York

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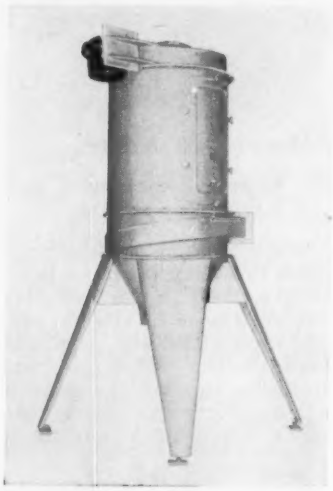
drawing processes. The unit takes only a few seconds to record a complete temperature profile—from the melt to a point on the fiber at room temperature. Because instrument operation is passive and remote, fibers are in no way disturbed during measurement.

Consisting essentially of a scanning optical system, control unit and an oscilloscope, the radiometer requires only a small working space. Either visual observation of data, or photographic and pen recording is possible. — **Radiation Electronics Corp., Skokie, Ill.** 205B



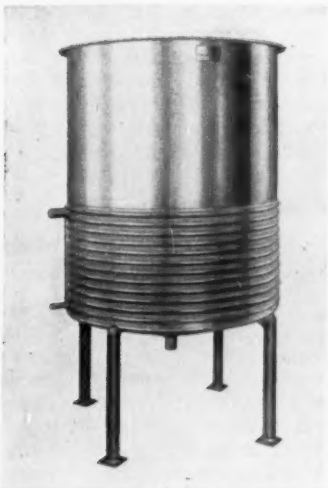
Car Unloader

Field-tested unit unloads bulk materials.

Operating with high internal vacuum, the Cyclo-Vac will pneumatically unload powder, crystal, flake and pellet materials from bulk rail cars or trucks. Either simple hookup of special adapters to the car's outlets, or direct insertion of an unloading line's nozzle into the bulk material readies the system for operation.

Within the equipment's all-metal shell, a high-speed, motor-driven rotor centrifugally separates larger-size solids from the air stream. A cyclone vortex knocks down finer particles. Depending on the material, conveying distance and method of discharge, Cyclo-Vac will un-

load up to 1,000 lb./min., with a recovery claimed to be in excess of 99.9%.—**Superior Separator Co., Hopkins, Minnesota.** 206A



Jacketed Vessel

Coil is integral part of the tank jacket.

Costing only about two-thirds as much as a conventional jacketed vessel, the new Langsenkamp holding tank is unique in that a panel coil forms an integral part of the tank jacket. Two sheets of metal welded together comprise the jacket; the outer panel is embossed to shape coil channels running into a header. Welds join the jacket to the finished tank.

Steam inlet to the coil header is 1 or 1½ in. diameter; condensate outlet is ¾ in. The vessels vary in capacity from 66 to 1,578 gal.—**F. H. Langsenkamp Co., Indianapolis, Ind.** 207A

Inert-Gas Generator

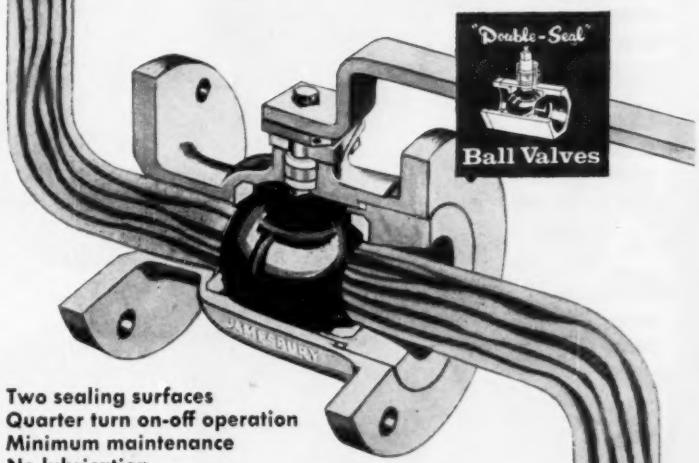
Packaged units have no fouling problems.

Operating on either gas or oil, new Sub-X generators can produce up to 150,000 scfh. of scrubbed inert gas. Design centers around a high-velocity burner, which exhausts the hot combustion products below the water level of a cooling tank—refractories are unnecessary.

HOW TO KNOW WHOSE VALVE YOU NEED...

for specifying on new equipment
replacing on present installations

Check these • Jamesbury "Double-Seal"™ Ball Valve FEATURES



- Two sealing surfaces
- Quarter turn on-off operation
- Minimum maintenance
- No lubrication
- Highest chemical and corrosion resistance
- Handles widest range of liquids and gases
- Replaceable and interchangeable seats and seals
- Standard design and dimensions
- Built-in abrasion resistance– extra long service life
- Wide selection of materials — Bronze, Aluminum, Stainless and Carbon Steels — Polyvinyl Chloride
- Size range depth– Pipe sizes ¼" to 8" Tubing sizes ¼" to 1½" (High pressure)
- Choice of styles — Screwed end ¼" to 2" Flanged end ½" to 8"
- Easily adapted for remote control devices
- Design permits repacking while valve remains on line
- High-flow capacity with minimum friction loss
- Positive shut-off — no leakage, from vacuum to full rated pressure. Low torque
- Self-compensating for temperature and pressure
- Readily available from local distributor stock

Jamesbury "Double-Seal"™ Ball Valves are ideal wherever zero *leakage* is an important requirement. The absence of metal-to-metal contact of working parts eliminates galling and corrosion, thus assuring *extensive* and *reliable* service.

Double-Check jamesbury Features:

- ☐ Send for descriptive "At Your Service" booklet.
- ☐ Write for complete catalog under your *company letterhead.*
- ☐ Inquire about local Jamesbury Stocking Distributors.

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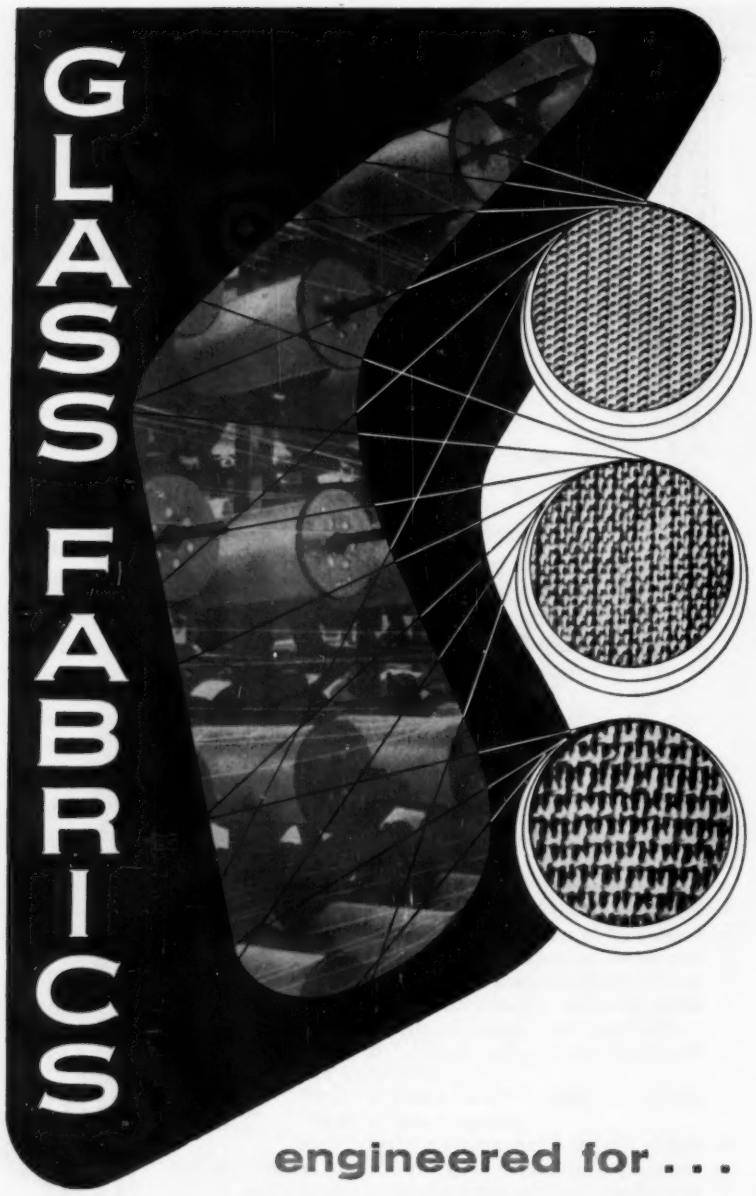

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Rate of water change controls exit gas temperature. Since this arrangement does not rely on heat transfer coils, untreated river water suffices as coolant.

Sub-X generators are available either for manual control or as packaged automatic systems complete with compressor, dryer and gas-analyzer controller.—**Thermal Research & Engineering Corp., Conshohocken, Pa.** **207B**

Flow Meter

New area-type unit offers versatility, stability.

According to the manufacturer, the new Series 5000 Taper-Flow meter measures flow rates with new standards of float stability. The float lines-out quickly without bobbling—visual averaging is unnecessary. The unit also features a "quick-out" flow tube for easy cleaning and range change. For high-pressure or dark-fluid measurements, a stainless steel jacket equipped with top-mounted magnetic readout replaces the glass jacket.

Standard capacities range from 0.0001 to 30 gpm. of water; change of float size varies capacity 100-fold. Accessories include electric transmitters, heat-transfer units and lighting attachments. — **C-Mar Corp., Manasquan, N. J.** **208A**

Flow Check Snubber

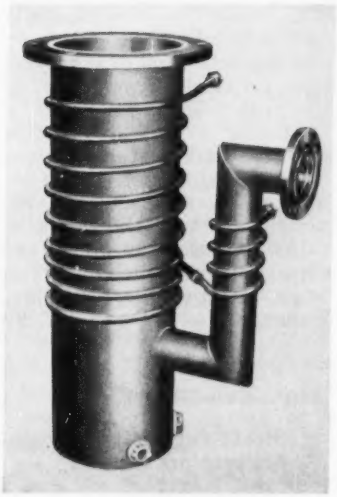
Offers instrument protection, worker safety.

Housed in a unit only 6 in. long, a new flow check snubber provides a low-cost, fool-proof method for protecting workers and valuable instruments.

A free-floating piston at the snubber's upstream side seals the port to the instrument in the event of instrument-system rupture, thus preventing escape of flammable or toxic media to the atmosphere. And a built-in, porous stainless-steel element prevents transmission of line surges and pulsations to the sensing elements.

Capable of withstanding pres-

sure differentials as high as 30,000 psi., the unit works well with equipment actuated by bourdon tubes or diaphragms. —**Chemiquip Co., New York, N. Y.** **208B**



Diffusion Pump

New high-speed unit for high-vacuum stations.

Higher pumping speed, lower backstreaming and greater forepressure tolerance than any competitive 4-in. diffusion pump are claimed by manufacturer of the EP4W 4-in. model. Actual pump specifications include: pump speed of 420 l./sec. at 5×10^{-5} mm. Hg; backstreaming of 0.04 cc./hr. at 25 C.; and limiting forepressure tolerance of 525 microns at 5×10^{-5} mm. Hg.

Body, flanges and cooling coils of the EP4W are stainless steel. To insure trouble-free joints, the entire assembly is Nicobrazed. — **Veeco Vacuum Corp., New Hyde Park, New York.** **209A**

Vacuum Gage

For routine operation in the millimeter range.

Designed for routine industrial processing, a new vacuum gage reads, records, and controls absolute pressures in the hard-to-measure range of 0.1 to 20 mm. Hg. An inexpensive,

"Difficult" Pressure Protection Problems?

Solve Them With...

BS&B *Safety Heads!*

BS&B's D and DV Rupture Discs, which are fully interchangeable in BS&B Safety Head flanges with conventional type pre-bulged discs, are engineered to give highly desirable Safety Head protection to those pressured systems in which one or more of the following "difficult" conditions prevail:

1. When operating pressure must be close to relief pressure.
2. When high operating temperatures are involved.
3. When alternating pressure and vacuum prohibits the use of standard one-layer rupture discs.
4. When pulsating pressure conditions prevail.
5. When a combination of metal and plastic disc construction is needed to obtain lower rupture pressures.

BS&B D and DV Rupture Discs have these advantages:

1. Fast action and unrestricted relief openings.
2. Wider rangeability in selection of metals and plastics for disc components.
3. Longer service life.
4. Rugged construction for added protection against possible damage by rough handling.

OVER 60 YEARS — BS&B — ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

Let BS&B Safety Heads solve your pressure protection problems. Our engineers will gladly evaluate your pressure system to assist you in proper selection of Safety Heads.

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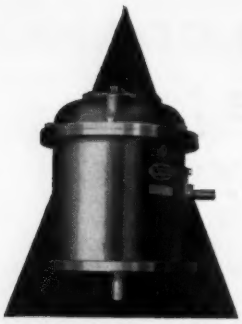

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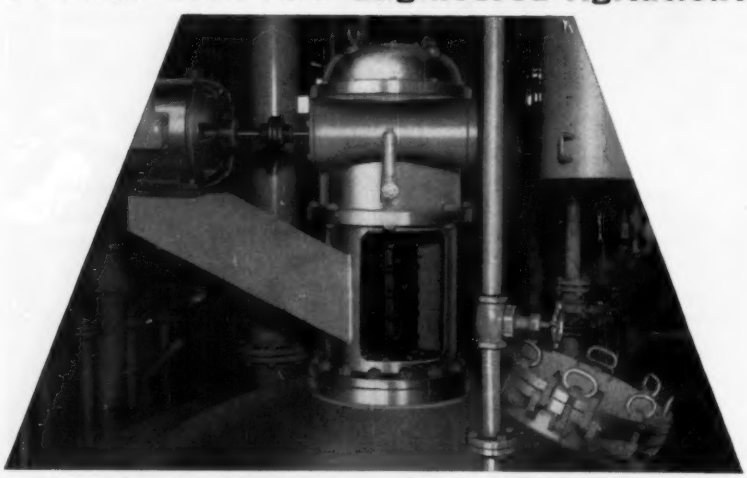
. . . with NETTCO Engineered Agitation!



INCREASE PRODUCTIVITY, lower power costs, and minimize maintenance requirements . . . with "process-rated" Model WT agitators by Nettco. Standardized components (motor, drive, shaft, stirrer) can be combined to suit your most exacting size, speed, HP or other process specifications. Check the design features of the Model WT tank top agitator . . .

- Worm gear reduction drives
- Ratios from 3.5:1 to 68:1
- Seven sizes available
- Complete range of speeds
- Minimum moving parts
- Large diameter vertical shaft
- Widely spaced, oversized Timken bearings
- Fully enclosed — dust, fume, moisture-proof
- Splash lubrication, drip-proof design
- Oil-trapped against leakage

Model T units, featuring helical gear trains and worm gears in combination, offer ratios from 6.25:1 to 100:1 in numerous "process-rated" models designed for dependable, economical operation. Ask Nettco agitation engineers for recommendations. Request Bulletin 551 and data sheet from **New England Tank & Tower Company, 87 Tileston Street, Everett 49, Mass.**

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- ☐ Portable & Tripod Mixers—Spec. Sheets
- ☐ Pipeline-Flomix®—Bulletin 531
- ☐ Side Entering—Bulletin 532

shock-resistant gage tube houses a chemically inert, noble-metal thermopile—the highly accurate sensing element. Directly heated, the thermopile operates at temperatures low enough to prevent surface reactions and evaporation of thermocouple materials.

If deposits of oil or other foreign materials accumulate in the gage tube, it fails-safe by indicating a pressure that is too high rather than too low. Original calibration is restorable on cleaning and restandardizing. Interchangeable gage tubes, indicators, recorders and controllers are available from stock.—**Hastings-Raydist, Inc., Hampton, Va.** 209B

Abrasive-Gas Fans

Heavy-duty units for high-temperature service.

Boiler gas recirculation, fly ash precipitator purging and rotary kiln exhausting are typical operations requiring fans capable of handling abrasive gases at elevated temperatures. The new line of Series 7000 centrifugal fans possesses this capability. Open radial blading with heavy tapered-blade sections minimizes stress on rotating parts. In addition, ribbed blade liners are available for extra-severe abrasive service.

In ratings for 10,000 to 50,000 cfm., and pressures to 70 in. H_2O, Series 7000 fans operate satisfactorily over a temperature range of 20-850 F.—**Westinghouse Sturtevant Div., Boston, Mass.** 210A

Centrifugal Extractor

Removes moisture from exhaust of gas scrubbers.

Installed on the existing stack of any wet-gas scrubber, a new centrifugal moisture extractor functions by changing the direction of exhaust gas flow from vertical to a cyclonic path. Centrifugal action imparted by stationary impeller blades removes all free moisture and some of the remaining entrained dust. Moisture impinges on the

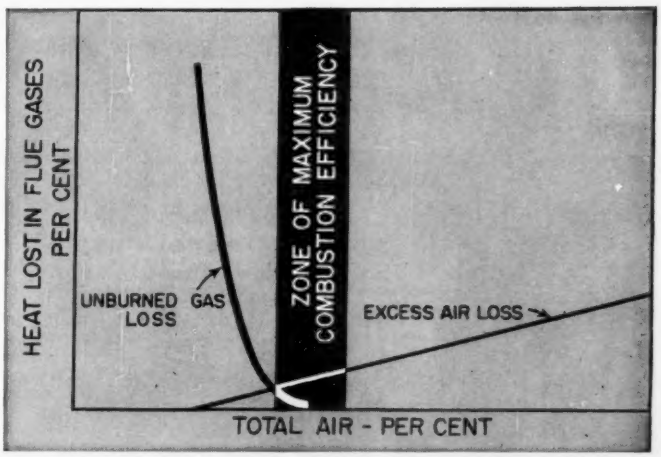
How to get maximum combustion efficiency . . . measure <u>both</u> combustibles and oxygen

Simultaneous measurement of both oxygen and combustibles is needed to obtain optimum combustion. No instrument that measures only one of these two interdependable factors can give you the full information necessary.

Now, Bailey offers two units, each giving a continuous and simultaneous double check on combustion efficiency: a permanent analyzer-recorder which records both factors on a single chart; and a new light weight, portable unit which indicates both factors.

Both instruments measure: (1) excess air—regardless of the fuel or combinations of fuel being burned, (2) mixing efficiency of your fuel burning equipment by showing per cent combustibles in the flue gas.

Both units are designed to increase efficiency in the furnace operations of the steel industry, on glass tanks, cement and lime kilns, ceramic and refractory kilns, steam boilers and also on direct and indirect-fired furnaces in the metal processing industries. To prevent your money from becoming waste gas, look into these two efficiency provers. A Bailey engineer will be glad to give you details or write us for product specifications.


HEAT LOST IN FLUE GASES PER CENT
UNBURNED GAS LOSS
ZONE OF MAXIMUM COMBUSTION EFFICIENCY
EXCESS AIR LOSS
TOTAL AIR - PER CENT

Maximum Combustion Efficiency is secured by keeping the sum of Excess Air Loss and Unburned Gas Loss to a minimum. To do so by the direct method simply measure both oxygen and combustibles in flue gas.

For portable use—
HEAT PROVER Analyzer

The famous Cities Service HEAT PROVER analyzer is now Bailey built and sold. Weighing only 25 pounds, it is a self-contained automatic analyzer including a sampling tip and hose plus a thermocouple for temperature measurement.

Instrument dials are dual range for greater accuracy and sensitivity.

For permanent installation
Oxygen-Combustibles Recorder

The Bailey Oxygen-Combustibles Analyzer-Recorder coordinates both records on one chart. These records enable the operator to keep fuel burning equipment performing continuously in the zone of maximum combustion efficiency. Excess air may be reduced to the point where combustibles begin to show.

G 40-1

Instruments and controls for power and process

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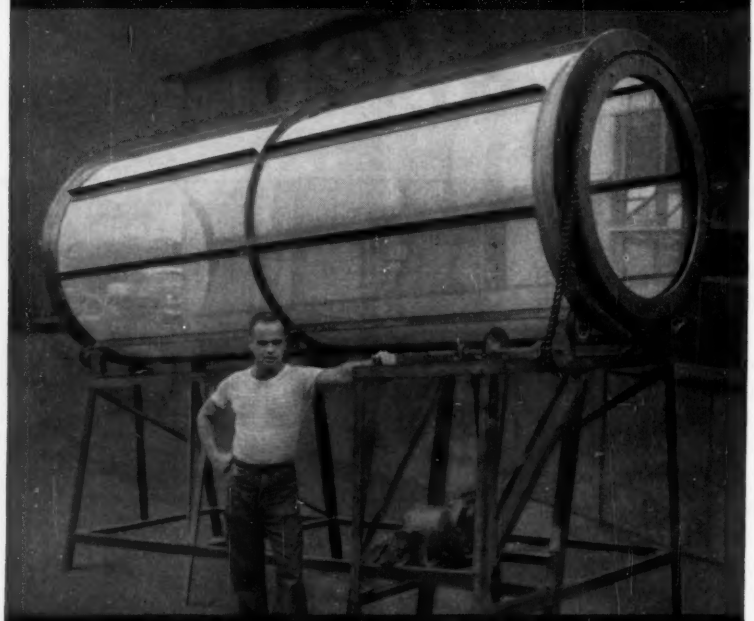

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inside of an outer shell, and collects at a drain outlet for disposal.

Available in five sizes to handle flows from 10,000 to 35,000 cfm., the units also feature an operator-controlled backwash system for periodic cleaning.—**The Johnson-March Corp., Philadelphia, Pa.** 210B

BRIEFS

Level controller utilizes a small movement between make-break contacts to provide high sensitivity to level change. For liquids with specific gravity above 0.3; pressures to 5,000 psi., temperatures to 500 F.—**Magnetrol, Inc., Chicago, Ill.** 212A

Coolers for liquids and gases, available in capacities to 18-million Btu./hr., evaporate water spraying over a set of coils to remove feed heat. Automatic control to wet-bulb temperatures by variation of circulating-air rate.—**Niagara Blower Co., New York, N. Y.** 212B

Air sampler collects airborne particulate pollutants, either radioactive or non-radioactive. Blower inhales up to 75 cfm., as measured by a self-contained orifice meter. Filters retain dusts.—**Nucleonic Corp. of America, Brooklyn, N. Y.** 212C

Dual-purpose valve, a non-lubricated plug that opens and closes with a quarter turn, performs also as a check valve in the open position. Now available for 2-in. pipe; other sizes soon.—**Frank Wheatley Supply Co., Tulsa, Okla.** 212D

Monitoring service conducts continuous or periodic environmental radioactivity surveys. Includes checks on air, rain, soil, vegetation, animals and other items of area's food chain.—**Nuclear Science & Engineering Corp., Pittsburgh, Pa.** 212E

Package boiler features a new 3-pass design that is 80%

REDUCE OPERATING COST of VACUUM SYSTEMS with this "AERO" (air-cooled) VAPOR CONDENSER

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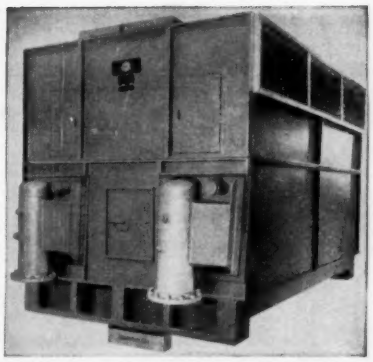

Niagara Aero Vapor Condenser Panel Casing construction gives access to all parts, saves first costs in shipping and installation.

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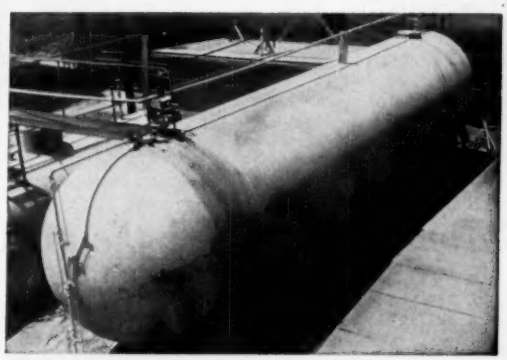

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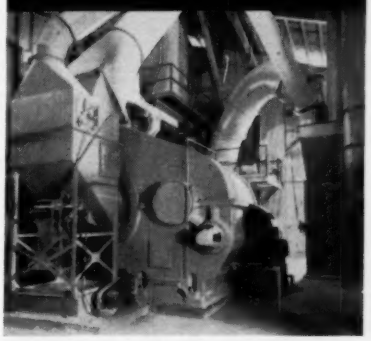

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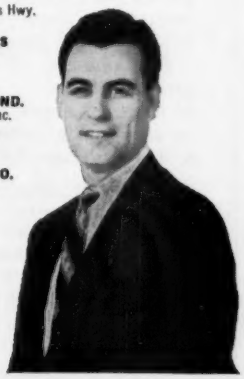

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efficient on oil or gas. Capacities from 1,725 to 31,050 lb./hr. high- or low-pressure steam. Water-cooled rear combustion chamber.—**Titusville Iron Works, Titusville, Pa.** 212F

Supervisory control system, designed for precise remote reading and control of process variables, is 100% digital. Fully automatic selection confirmation and error checking.—**Shand and Jurs Co., Berkeley, Calif.** 215A

Vibratory feeder, with a capacity rated at 10 tons/hr., is the latest addition to manufacturer's line. Unit claims: simple installation, low power consumption, minimum maintenance.—**Eriez Mfg. Co., Erie, Pa.** 215B

Equipment Cost Indexes . . .

	March 1958	June 1958
Industry		
Avg. of all	231.2	230.7
Process Industries		
Cement mfg	222.9	222.2
Chemical	232.4	231.7
Clay products	216.6	216.0
Glass mfg	219.4	218.8
Paint mfg	223.8	223.1
Paper mfg	223.9	223.3
Petroleum ind	228.6	227.9
Rubber ind	231.4	230.7
Process ind. avg	228.8	228.2
Related Industries		
Elec. power equip	234.2	234.3
Mining, milling	233.8	233.1
Refrigerating	261.5	260.7
Steam power	219.5	218.4

Compiled quarterly by Marshall and Stevens, Inc. of Ill., Chicago, for 47 different industries. See Chem. Eng., Nov. 1947, pp. 124–6 for method of obtaining index numbers; Feb. 24, 1958, pp. 143–4 for annual averages since 1913.

For More Information . . . about any item in this department, circle its code number on the **Reader Service** postcard (p. 229)

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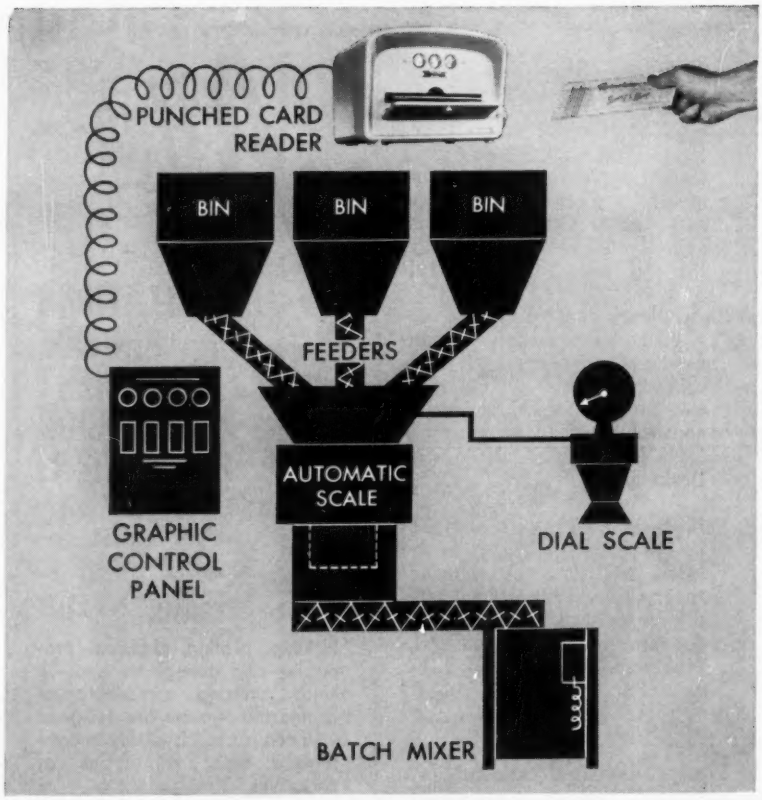

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To Stimulate Isotopes

TRACER APPLICATIONS FOR THE STUDY OF ORGANIC REACTIONS. Interscience Publishers, New York. 291 pages. $7.50.

Reviewed by E. D. Goldsmith, Research Coordinator, New York University, New York, N. Y.

Author has tried to provide a "comprehensive survey of tracer applications in organic chemistry." It is his hope to stimulate the use of isotopes among organic chemists. Volume is well written and both the subject and author indexes are exhaustive.

In addition, three appendixes list: textbooks dealing with the properties, uses and analysis of isotopes, and a partial list of review articles on the applications of isotopes; texts on organic reaction mechanisms; complete coverage of the literature through early 1955.

Electro-Organic Reference

ORGANIC ELECTRODE PROCESSES. By Milton J. Allen. Reinhold Publishing Corp., New York. 188 pages. $6.50.

Reviewed by G. J. Janz, Department of Chemistry, Rensselaer Polytechnic Institute, Troy, New York.

This is a concise and comprehensive book prepared by the author in response to many requests for a monograph in electro-organic chemistry based on his lectures in this field.

Development of the subject proceeds from basic discussions of electrochemical principles, instrumentation and techniques to a thorough account of the various phases of electro-organic chemistry.

Details of the redoxotrol apparatus, the focus on the application of principles to practice, and the careful assessment of the status of knowledge in this field, together with some five hundred

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J. B. BACON

relevant references are features that make this work welcome both as a guide in experiment and as a reference towards a better understanding of electro-organic chemistry.

Chemists generally, and organic chemists particularly, will find this a most useful book.

BRIEFLY NOTED

ENGINEERING CONSULTANTS — Directory of the American Institute of Consulting Engineers. *American Institute of Consulting Engineers, 33 W. 39 St., New York 18, N. Y.* $2.50, *cloth-bound;* $1.50, *paper-covered.* Lists engineers and their firms, with some biographical data and information concerning services. Includes classified index to locate engineers for particular types of problems.

JOURNAL OF APPLIED CHEMISTRY (ZHURNAL PRIKLADNOI KHIMII), *Consultants Bureau, Inc., 227 W. 17 St., New York 11, N. Y.,* $60 *per year;* $20 *for libraries of educational institutions.* English translation of monthly Russian journal.

API SPECIFICATION FOR CENTRIFUGAL COMPRESSORS FOR GENERAL REFINERY SERVICES, Tentative Standard 617. 29 pp. Publications Dept., *American Petroleum Institute, 50 W. 50 St., New York 20, N. Y.* $1.50. Covers minimum requirements for design, inspection and tests for compressors (developing 5 hp. or more) used in refinery services handling air or gas.

MORE NEW BOOKS

THE PETROLEUM CHEMICALS INDUSTRY, 2nd ed. By Richard F. Goldstein. Wiley. $16.50.

HEAT EXCHANGERS — Applications to Gas Turbines. By W. Hryniszak. Academic Press. $10.

ADVANCES IN PETROLEUM CHEMISTRY AND REFINING. Edited by Kenneth A. Kobe and John J. McKetta, Jr. Interscience. $13.50.

FUNDAMENTALS OF CHEMICAL ENGINEERING OPERATIONS. By Maurice G. Larian. Prentice-Hall. $10.50.

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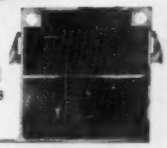

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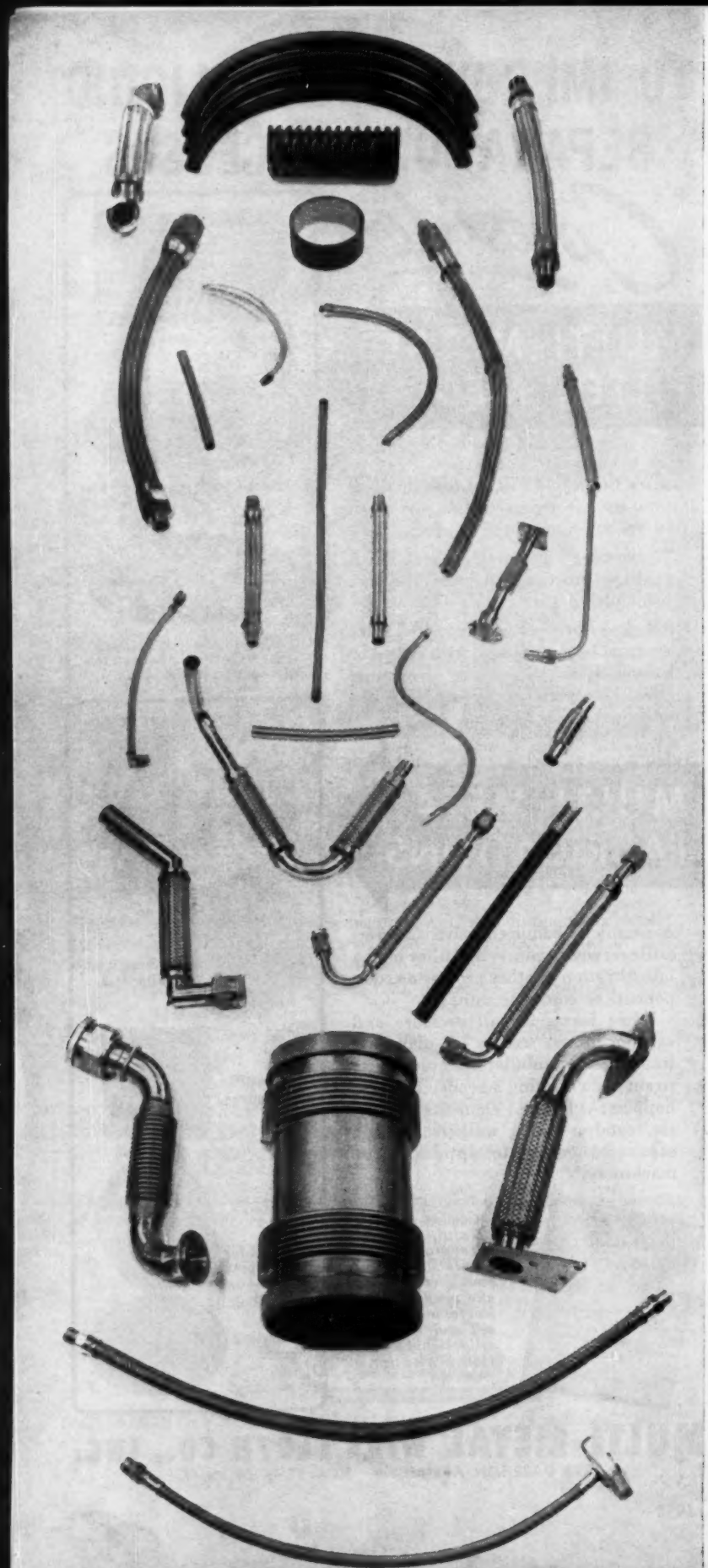

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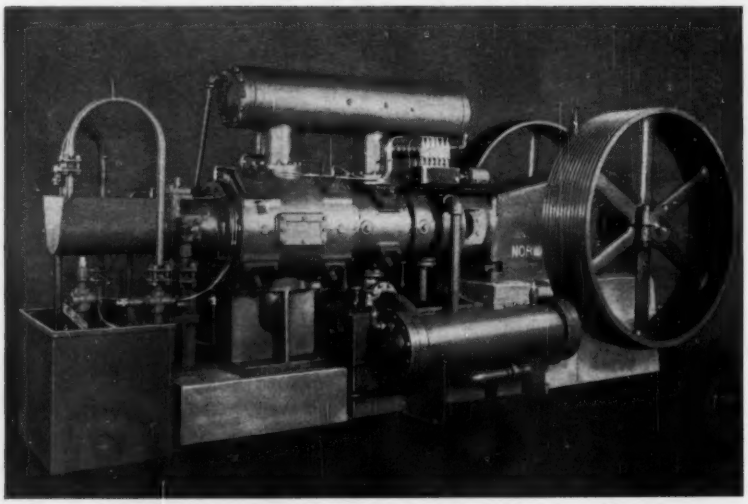
HIGH PRESSURE COMPRESSOR



The five stages on this heavy-duty tandem compressor require less horsepower and develop less heat than in four stages in producing 3000 lb. per square inch pressure in capacities up to 31,000 cfh.

Frames with double row roller bearings, reversible ring plate valves, force feed lubrication, generous intercooler coils are some of the features that make this horizontal compressor compact, sturdy and efficient to operate and maintain.

Every Norwalk compressor is test-run for eight hours at the factory, then taken down for complete inspection before re-assembly and shipment.

Norwalk makes compressors from single stage to six stages, from 125 to 25,000 lb. psi. Catalog on request.

NORWALK COMPANY, INC.

SOUTH NORWALK, CONNECTICUT

Makers of high pressure compressors since 1864

READER SERVICE . . .

TECHNICAL

Contents of This Issue

Chemicals & materials . . . 220
Construction materials . . 222
Electrical & Mechanical equipment 233
Handling & Packaging . . 225
Heating & cooling 225
Instruments & Controls . . 227
Mechanical equipment . . 223
Pipe, fittings, valves 228
Process equipment 233
Pumps, blowers, compressors 234
Services & processes . . . 238

Chemicals

Carbon Dioxide.....Liquid's new bulletin "Applications Unlimited" gives you an introduction to 37 ways in which CO_2 is being used in modern industry.
125 *Liquid Carbonic

Catalyst.....32 p. brochure explains how a synergistic zirconium drier compound permits paint formulators to replace lead completely. Advantages, how to apply.
220A Advance Solvents & Chem.

Chemicals.....Technical help for manufacturers of alkyd or polyester resins, from maker of phthalic anhydride, maleic anhydride, and fumaric acid.
51 *Pittsburgh Coke & Chemical Co.

Chemicals.....Latest alphabetical index of 81 of the company's coal tar chemicals. For each entry is given chemical structure, grades, purities, freezing points, etc.
220B Reilly Tar & Chemical

Chloride, calcium.....Now used as an industrial chemical—in manufacture of such diverse products as paper, portland cement, metallic sodium, petroleum, weedicides.
93 *Allied Chem.-Solvay

Dinitriles & Diamines.....prepared from Isosebacic Acid. Dinitriles are valuable as chemical intermediates & Diamines are useful in synthesis of polyamids.
107-108b *U. S. Industrial Chemicals Co.

Ethyl Alcohol.....New roles seen for Ethanol in medical & pharmaceutical fields. Developments include new nerve block application & improvement of Ruminant Nutrition.
107-108a *U. S. Industrial Chemicals Co.

Methyl isobutyl ketone.....Quick deliveries and considerable savings are advantages of ordering methyl isobutyl ketone from Carbide. Two booklets available on ketones.
179 *Union Carbide Chemicals Co.

* From advertisement, this issue

LITERATURE

E. M. FLYNN

Phosphates.....4 p. bulletin HSP-906 describes company's phosphates for boiler water conditioning. Discusses methods of feeding chemicals and controlling residual phosphate.
221A Hagan Chemicals

Plastic, Tygon.....Used in sheet form, as tubing, and as a liquid. Molds as readily as rubber and more resistant to chemical attack. Portfolio gives more information.
66 *U. S. Stoneware

Plasticizer.....Describes use of company's secondary plasticizer and lubricant in the manufacture of polyvinyl chloride. Current topics No. 134.
221B L. Sonneborn Sons, Inc.

Polyethylene.....Hi-fax, Hercules high-density polyethylene is now available for plastic packaging. Featherlight, unbreakable, heat resistant.
36 *Hercules Powder Company

Salt.....Using salt in its many industrial applications calls for technical knowledge & experience. Our research program can be put to work for you.
54 *International Salt Co.

Sapphire.....“Synthetic Sapphire, an Infrared Optical Material,” 11 p. bulletin P-917, is a resume of single crystal aluminum oxide growth, physical properties.
221C Linde Co.

Silicone Fluids.....8 p. “Engineering Guide to Silicone Fluids for Mechanical Applications” shows how fluids are exploited in damping, springing, coupling.
221D Dow Corning Corp.

Solvents.....Booklet “Shell Aromatic Solvents for the Coatings Industry” gives typical properties of these solvents. Variety of evaporation rates is shown.
75 *Shell Oil Company

Sulphur hexafluoride.....now being used in high voltage transformers instead of oil. Operations are much quieter; fireproof and explosion-proof; lower maintenance.
41 *Texas Gulf Sulphur Co.

*From advertisement, this issue

Want to build up your files and keep them up-to-date? You can get any publication in this comprehensive guide — free — just for the asking.

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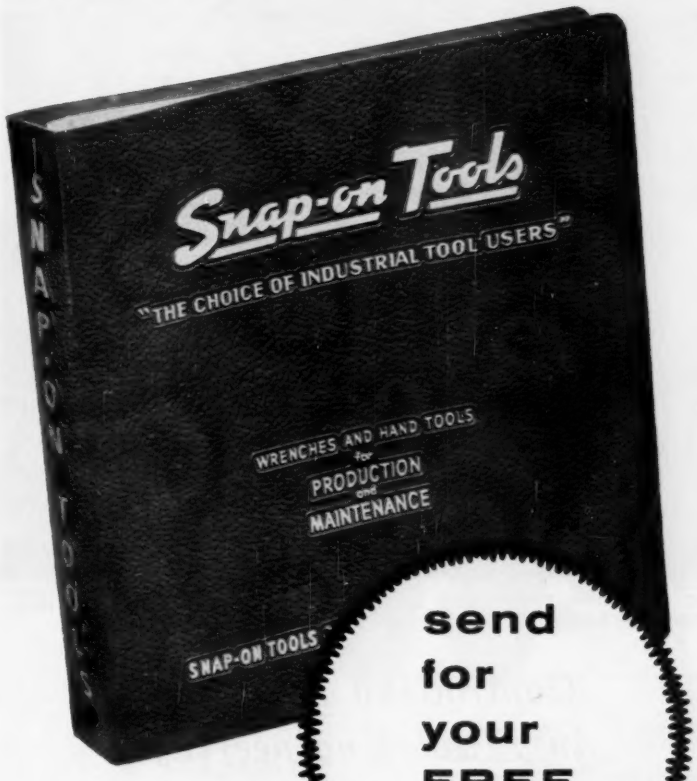
NEW Snap-on

INDUSTRIAL TOOL CATALOG



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Here is a complete, 156-page, hand tool buying guide for purchasing agents, engineers, production and maintenance officials — anyone concerned with the use of hand tools for assembly, maintenance, field service and original equipment repair kits.

Users of power-driven nut runners and impact wrenches will find this book a handy order guide to answer every socket need. Every type, every size is tabulated with important dimensions and specifications listed clearly.

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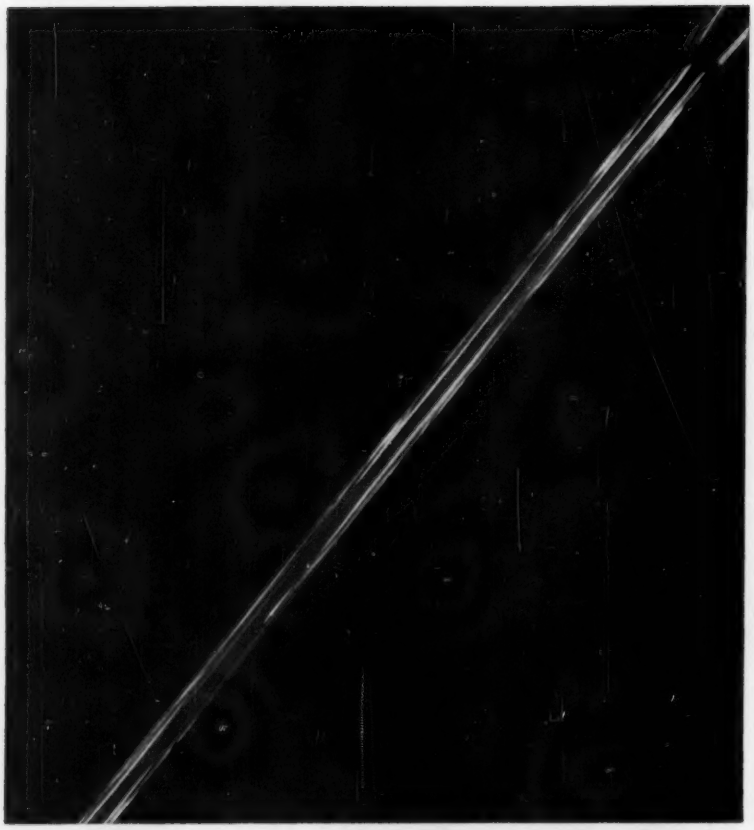

Using stop motion, photographer Bernard Hoffman 'freezes' a tiny jet of water. Discharged at high pressure, the stream is a solid, unwavering mass.

Controlling Pressure in Fluid Engineering

Pressure is always a problem . . . either how much you need, or what you can do in spite of it. Accurate control requires the relation of other factors, like volume, time, and resistance. To get these answers, you can depend on the engineering leadership of S. Morgan Smith.

Take butterfly valves. Parts for a wide range of standard R-S Butterfly Valves, capable of satisfying most processing requirements, are carried in stock for fast assembly and shipment. These R-S Valves, with their streamlined vanes, give you minimum pressure drop, save pumping power. Regulation and closure are quick, and you get uniform flow control through all positions in the normal regulating range.

To obtain full information on the complete SMS line – R-S Butterfly Valves, Rotovalves or Ball Valves – call our nearest representative. Or, write S. Morgan Smith Co., York, Pa., for data on standard valves or special applications.

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Sulfuric anhydride.....With "Sulfan" there is no waste acid. You can increase batch sizes or get more rapid through-put. Available in tank cars 750-lb. drums.
73 *Allied Chemical Corp.-Gen. Chem.

Surfactants.....N-acyl sarcosine surfactants are discussed in 15-p. technical bulletin. Chemical & physical properties, corrosion inhibition, analytical methods.
222A Geigy Chemical Corp.

Tanning Agent.....Maratan is a highly purified sodium lignosulfonate used in conjunction with chrome or vegetable tans to produce leathers of excellent quality. Bul. 116.
222B Marathon Corp., Chemical Div.

Textile Finish.....16-p. booklet describes use of the company's A-C Polyethylene 629 as a textile finishing agent. Product properties, preparation.
222C Allied Chemical Corp.

Veneer.....2 p. data sheet aims at anyone concerned with eliminating dangerous slips on stairs, catwalks, ramps. Company's product is compared with other coatings.
222D Monroe Co.

Wax Emulsions.....3 p. data sheet discusses the use of 3-methoxypropylamine in the preparation of wax and resin emulsions. Physical properties, toxicity.
222E American Cyanamid Co.

Yeast.....2 p. bulletin describes a new media component for the fermentation industry, a water soluble fraction of autolyzed Brewers yeast. Detailed chemical analysis.
222F Amber Laboratories

Zinc.....First issue of new quarterly newsletter, "The Zinc Spotlight," is available. 4 p. publication is aimed at engineers, designers, fabricators.
222G American Zinc Institute

Construction Materials

Alloys.....Four types of Hastelloy alloys, each specifically designed to resist certain corrosives. 104-page booklet gives properties & fabrication information.
185 *Haynes Stellite Co.

Corrosion-Proof Materials.....Storage tanks of all kinds, industrial floors for chemical processing areas & rigid plastic structures. All information in Bulletin CC-3.
215 Atlas Mineral Products Co.

Exchanger Tubes.....'Cold Drawn Wrought Iron Heat Exchanger and Condenser Tubes" cites service life comparisons and other pertinent data for wrought iron tubes.
222H A. M. Byers Co.

Fabrications.....Catalog 57 gives helpful, practical information on research, engineering & product services for better methods of solids-liquid separation.
217 *Multi-Metal Wire Cloth Co.

Fire Brick.....New 8-page brochure tells how insulating fire brick and Sil-O-Cel insulating brick can be useful for economical heat control through 3,000 F.
222I Johns-Manville

*From advertisement, this issue

LITERATURE . . .

Insulation Specifications.....New data gives typical average values on physical and thermal properties of 85% magnesia, calcium silicate and diatomaceous silica.
223A Magnesia-Silica Ins. Mfg.

Metal Castings.....Answer book points out the advantages and uses of malleable iron, pearlitic and grey iron, aluminum and magnesium. For parts, an ideal reference.
223B Dayton Malleable Iron Co.

Pipe & Tubing, Stainless Steel.....A new 44-page handbook contains data on applications, heat treatment, corrosion resistance, chemical & physical analysis, etc.
138 *Damascus Tube Co.

Stack Linings.....Folder summarizes the application of castable refractory materials to form continuous one-piece linings for boiler and other stacks.
223C Plibrico Co.

Stainless Steel.....New mill produces sheets to extremely close tolerances. Technical data on laboratory corrosion & specific grades of stainless steel are available.
106 *Jones & Laughlin Steel Corp.

Steel, Stainless.....widest selection & range of stainless types, shapes & sizes. Big capacity abrasive saw assures cutting accuracy also flame-cutting facilities.
154 *Ryerson Steel

Tantalum.....“Corrosionomics”, a journal of useful information for the solution of corrosion problems. Technical data on Tantalum, its uses & properties.
204 *Fansteel Metallurgical Corp.

Titanium.....Write for bulletin on corrosion resistant properties of titanium. Titanium liners & dip-tubes win over stainless steel shells and flanges.
58 *Mallory-Sharon

Wire Cloth.....A 94-page catalog & stock list gives the full range of wire cloth available. describes fabrication facilities & gives useful metallurgical data.
212 *Cambridge Wire Cloth Co.

Electrical & Mechanical

Connectors & Panels.....Quick-coupling connectors permit fast making & breaking of circuits. Panels are available in many compact shapes & sizes. Bulletin 23-E.
BL211 *Thermo Electric Co., Inc.

Diesel Engines.....Operated on diesel, Dynafuel or spark-ignition gas, the line of described 4-cycle engines are available in 12 or 16 cylinders. Design features.
223D Nordberg Mfg. Co.

Drive, Screw Conveyor.....a complete package drive with quick-removable Driving Shaft. Available from stock with 4 different size shafts. Technical data in bulletin.
190 *Dodge Mfg. Corp.

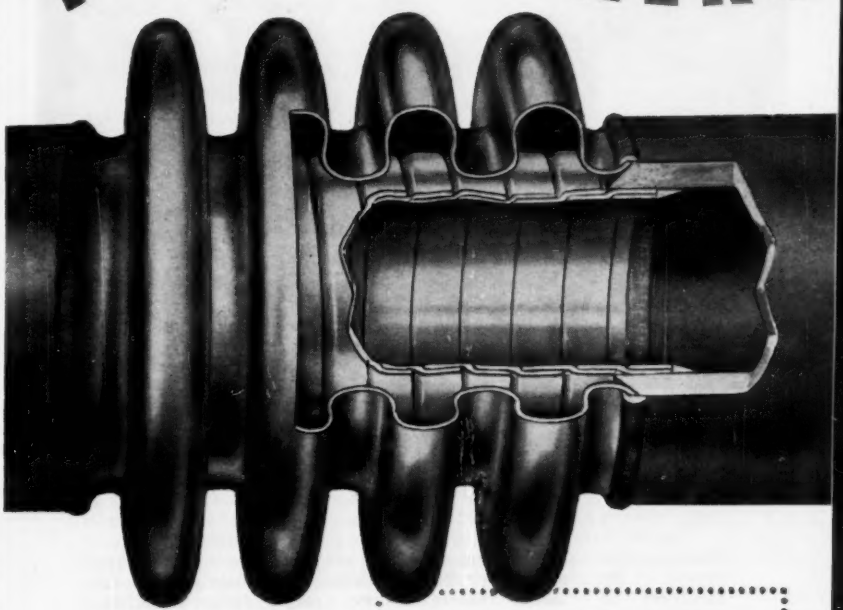
Drives, variable speed.....Controls stretch and tension on web processes. All electric and operates from a-c circuits. Bulletin No. D-2506 tells further applications.
*Reliance Electric & Engineering
247

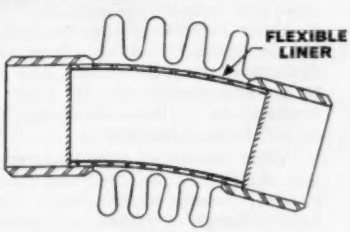
* From advertisement, this issue

Flexon®

EXPANSION JOINTS *NOW* WITH

FLEXIBLE LINERS



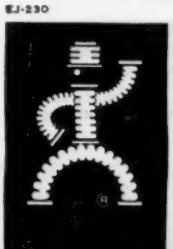


Lateral or angular motion without flow reduction of conical type liners

No more need to specify oversize expansion joints to allow for the flow reduction through an ordinary conical liner! Now you can get Flexon Expansion Joints with flexible liners that give full flow. Easier to install, too, because flow can be in either direction. A section of smooth interior, Flexon stainless steel hose forms the liner—cuts flow turbulence, reduces carrier temperature and permits full pipe movement either laterally, angularly, or axially. The cost is no more than for conical sheet liners.

Write today for facts about this new Flexon development—and your copy of the 28-page Flexon Expansion Joint Design Guide, the complete handbook for solving every problem in pipe motion.

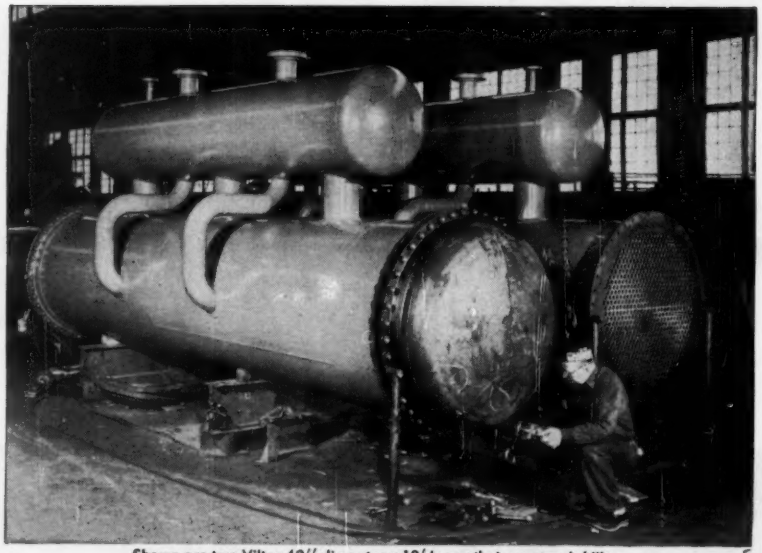
EJ-230



Flexonics corporation

EXPANSION JOINT DIVISION • 1317 S. THIRD AVENUE, MAYWOOD, ILLINOIS

EXPANSION JOINTS · METAL HOSE · NON-METALLIC HOSE · BELLOWS · AIRCRAFT COMPONENTS



Shown are two Vilter 48" diameter x 18' long ethylene glycol chillers built to A.S.M.E. standards.

VILTER

can meet your HEAT EXCHANGER NEEDS

The above two 48" diameter x 18' long ethylene glycol chillers are typical of the custom work Vilter is doing in the field of heat exchangers and pressure vessels to meet exactly design specifications and budget requirements.

Vilter has successfully resolved many problems of cooling under intense pressures, and has designed and produced hundreds of heat exchangers, pressure vessels, and high pressure synthesis condensers to exacting specification for many types of chemical and petroleum applications. Vilter vessels are built in conformance to A.S.M.E. or T.E.M.A. standards.

Vilter makes all four basic types of heat exchangers: shell and coil, shell and tube, shell and tube bundle, and atmospheric . . . and in every possible modification. Vilter can give you the most efficient heat exchange equipment and pressure vessels with working pressures as high as 10,000 psi.

The Vilter facilities include automatic welding, X-ray and Zyglo-Pentrex inspection.

Today, more than ever before, the leading names in both the chemical and petroleum industries are turning to Vilter for their special vessel needs. Consult with Vilter about your needs.

Write for these helpful bulletins to The Vilter Manufacturing Company, Dept. K-709, 2217 S. First Street, Milwaukee 7, Wisconsin.

Bulletin 707
Vilter Condensers
Brine Coolers
Heat Exchangers

Bulletin 827
Vilter Industrial
Heat Exchangers

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REFRIGERATION and AIR CONDITIONING

THE VILTER MANUFACTURING COMPANY, Milwaukee 7, Wisconsin

Air Units • Ammonia & Freon Compressors • Booster Compressors • Baudelot Coolers • Water & Brine Coolers • Blast Freezers • Evaporative & Shell & Tube Condensers • Pipe Coils • Valves & Fittings • Pakice & Polarflake Ice Machines

LITERATURE . . .

Gear, planetary.....for high speeds . . . high horsepower. Small size, light weight; wide application; convenient arrangement. Bulletin 2400 gives other features.
43 *DeLaval Steam Turbine Co.

Mobile Radio.....Fast-reading booklet is a reference primer on the entire field of 2-way mobile radio. Covers industrial applications and method for acquiring.
224A Motorola

Motoreducer.....Change motors in minutes with Falk all-steel motoreducers. No long and costly down time involved. Replacement is not limited to original make of motor.
35 *The Falk Corporation

Motors.....Elliott's explosion-proof motors are self-cleaning and self-cooling. Designed especially for hazardous locations. NEMA frames through 505, ratings to 100 hp.
26-7 *Elliott Company

Motors, Open-type.....offer double-protection of rugged corrosion-resistant cast iron frames & drip-proof enclosures. Details in Bulletin MU-223.
126 *Wagner Electric Corp.

Motor-Starter.....Bulletin 709 gives details on across-the-line solenoid starters. Made in eight sizes with maximum ratings to 300 hp, 220 volts; 600 hp, 440-550 volts.
113 *Allen-Bradley Co.

Packings.....For your tough-to-handle corrosive & toxic liquid problems at temperatures from 120 to +500 F. Bulletin P-325 details fluid & gas handling problems.
205 *Crane Packing Co.

Pump Motors.....New instruction manual helps maintenance men to have time in installing, inspecting and servicing Verticlosed pump motors.
224B U. S. Electrical Motors

Rectifiers.....Allis-Chalmers excitron rectifiers give you many advantages—internal cooling system, arc-over-free tube, enameled anode seals, grid phase control.
39 *Allis-Chalmers Mfg. Co.

Rectifiers, silicon.....Helps you curb the high cost of processing. Low cost, high efficiency, long life, ease of installation, no costly outages.
30-31 *Westinghouse Electric Corp.

Reels, Extension.....Booklet is offered giving complete specifications, price lists & other data on the new weather proof & explosion proof reels. Bulletin 504.
224C Appleton Electric Mfg. Co.

Speed Reducers.....A 10-page manual discusses selection, horsepower ratings, dimensions, construction, installation and maintenance of shaft-mounted speed reducers.
224D Westinghouse

Starters, motor.....Pushbutton automatic starters give you complete protection during starting, acceleration and while running at synchronous.
53 *The Electric Controller & Mfg. Co.

Switches.....Bulletin 21 describes the complete line of small enclosed switches featuring design that exposes the terminals for easy wiring.
224E Micro Switch

* From advertisement, this issue

System, Electrical.....For a new plant or to expand facilities, technical assistance & engineered equip. is available, including transformers, circuit breakers & motors.
2-23 *General Electric Co.

Handling & Packaging

Bulk Handling....."Bulk Handling and Storage of Liquid Synthetic Resins" is a 40-page booklet covering items such as storage layout and pumping systems.
225A American Marietta Co.

Conveyor Air.....Bulletin 401 describes a conveyor for handling fine granular and dry pulverized materials pneumatically. Can be either portable or built-in.
225B Morse Boulger Destructor

Conveyors, Airstream.....A new 32 page brochure presents detailed information on how these conveyors solve bulk materials handling problems. Bulletin 530.
128 *Dracco, Div. of Fuller Co.

Conveyors Vibrating.....New 16-page manual gives information on materials handling operations that can be performed simultaneously. Flow charts, capacities, etc.
225C Ajax Flexible Coupling

Fork Truck.....New four-page bulletin provides complete operating and design specifications on a 3,000-lb. capacity, electric-powered fork truck.
225D Elwell-Parker Electric Co.

Materials Handling.....Complete data on the new model H-25 Payloader available. Handles more material per hour at less cost per ton. Carry capacity of 2,500 lbs.
8-9 *The Frank G. Hough Co.

Pneumatic Control....."Basic Pneumatic Control", discusses the systems engineering approach to the selection and use of pneumatics. Basic systems and advantages.
225E Westinghouse Air Brake Co.

Tanks.....Suppliers to chem. process industry . . . elevated tanks, pressure vessels, equipment from aluminum, monel and other alloys. Write for "Tank Talks."
BL213 *R. D. Cole Mfg. Co.

Heating & Cooling

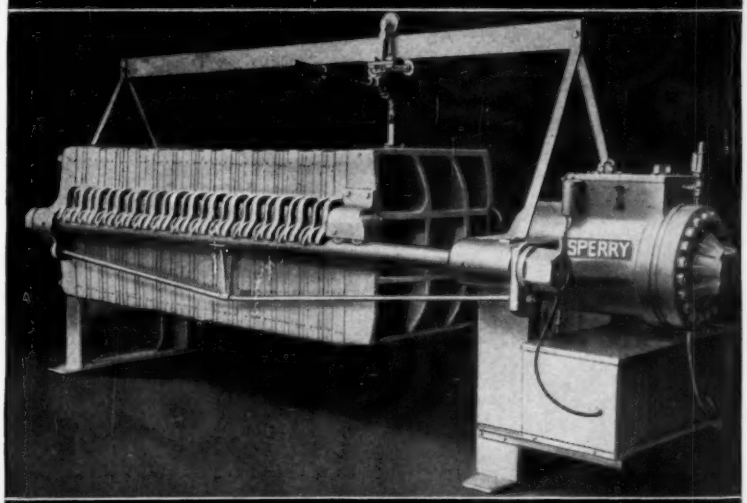
Boilers, steam.....Package steam boilers for power, process or heating give versatility with economy. Available in capacities from 10,000 to 50,000 lbs. steam/hour.
177 *Henry Vogt Machine Co.

Condensers, Vapor.....gives more capacity at a saving of steam & power. Unit capacities up to 15 million BTU. For full information request Bulletin 129R.
TL213 *Niagara Blower Co.

Cooler.....Link-Belt's Roto-Louvre cooler absorbs more heat from material being cooled than other types of coolers for a given capacity. Specialist will make estimate.
15 *Link-Belt

* From advertisement, this issue

LOW DOWNTIME



with a plate and frame SPERRY FILTER PRESS

If your present filter system is inadequate to meet increased production demands . . . if excessive shutdowns, cleaning and manpower problems are dragging out your filter cycle so as to slow down your production cycle — now is the time to investigate all the advantages of a plate and frame filter press — as modernized and custom engineered to your particular application by D. R. Sperry & Company.

Through extreme versatility of design, a Sperry Filter Press can simplify the most complex filtration requirements. Varying batch sizes . . . incompatible products . . . cake removal . . . and constant cleaning cease to be problems. Instead — the cycle is reduced . . . filtering area and pressures are increased . . . downtime losses are reduced to a minimum . . . and with labor-saving automatic closing attachments and plate shifting devices, complete control is reduced to a one man operation.

Sperry Filter Presses are available in a design and capacity to handle any filterable mixture and any filter material . . . with center, side or corner feed; open or closed delivery; high or low temperature control; and your choice of labor saving devices.

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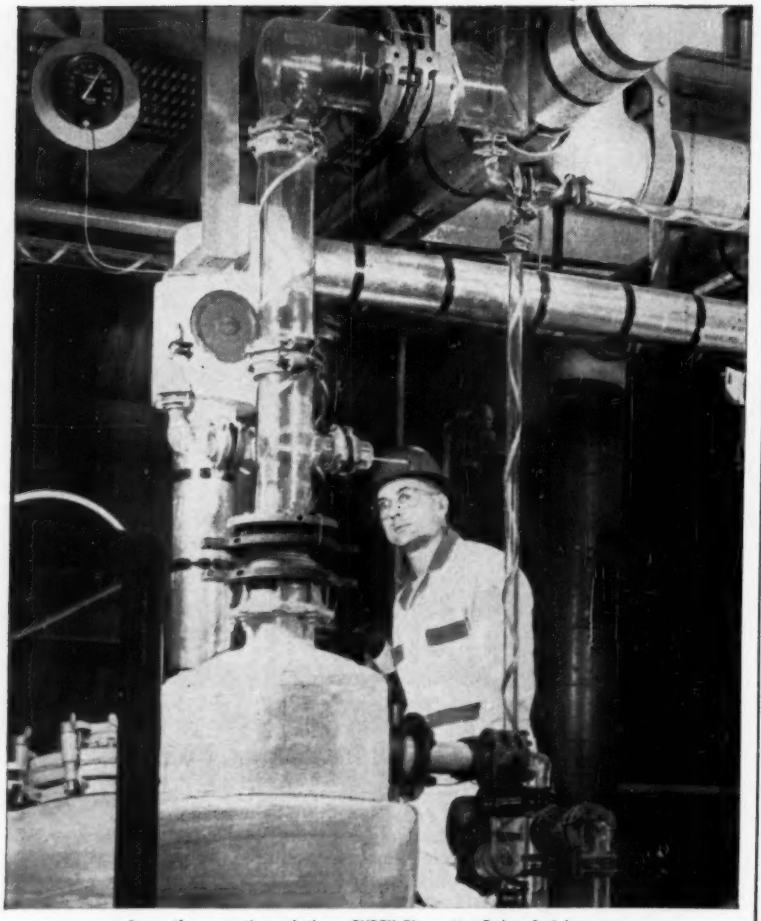


Raw ether runs through these PYREX Pipes at a Baker & Adamson plant without a trace of corrosion or product contamination.

Between this man and a highly volatile chemical lie only PYREX® Pipe and confidence

At this ether distillation operation in a Baker & Adamson plant precaution is the password; you can see it in the hat, the gloves, the static ground wrappings on the pipe . . . *and the pipe itself.*

The pipe is strong. You can't take chances with pure ether. "Double-Tough" PYREX Pipe is made to take pressure and heat and a goodly amount of mechanical abuse.

The pipe cannot corrode. Not from ether or from any other chemical but hydrofluoric acid and hot alkalies.

The pipe cannot contaminate. It's completely inert—vital when you're making an A.C.S. Reagent Grade chemical.

And the pipe is transparent. You can see what's going on inside PYREX Pipe. Maintenance men can judge its condition at all times just by looking. Should a blocking occur they can spot it exactly and ascertain its nature *without* opening the pipe.

Such remarkable features should certainly induce you to learn more about this remarkable pipe by writing to us for Bulletin PE-3.

CORNING GLASS WORKS
19 Crystal Street, Corning, New York
Corning means research in Glass

LITERATURE . . .

Coolers, air.....Air-cooling of liquids and gases with Trane fluid coolers now cuts costs, solves water supply problems for more and more refineries, chemical plants.
18-19 *The Trane Company

Cooling Unit.....Improve your product and cut costs with Votator heat transfer equipment. Continuous cooling, controls heat of reaction, emulsifies, crystallizes.
2nd Cover *Girdler-Chemetron Div.

Generators, packaged steam.....Semi-automatic combustion controls; 44″ self-supporting stack. Staggered boiler bank tubes. Available in capacities from 10,000 to 60,000 lbs/hr.
77 *Foster Wheeler Corp.

Heat Exchangers.....Bulletin 707 outlines Vilter Condensers, Brine Coolers & Heat Exchangers. Bulletin 827 gives information on Vilter Industrial Heat Exchangers.
224 *The Vilter Mfg. Co.

Heat Exchangers.....Standard dimensions, materials and engineering data in two new bulletins describe two new heat exchanger lines of the fixed-bundle variety.
226A Yates-American Machine Co.

Heat Exchangers.....Engineered to requirements to provide you with scientifically rated & designed heat exchangers for maximum heat transfer with good operation.
116 *Yuba Consolidated Industries

Heaters.....Bull. 149, "Gradiation Heating for Petroleum & Chemical Processing", gives complete information where heat capacities under 10 million Btu per hour are desired.
130 *Selas Corp. of America

Heating Coils.....New catalog covers complete line of manufacturer's heating coils. Tubes are pitched in the casing to assure positive condensate drainage.
226B Young Radiator Co.

Kiln, rotary.....Bulletin 1115 gives whole story of Traylor leadership and experience in rotary kiln design and manufacture. Features oil reservoir and oiling mechanism.
7 *Traylor Engrg. & Mfg.

Thermo-Panels.....take the place of pipe coils. A 52-page Bulletin #355 gives technical data, while Bulletin 258 covers design and price information.
TL238 *Dean Products Inc.

Traps, Steam.....Publication assists the engineering and maintenance aspects of sizing, specifying, selecting and buying of steam traps.
226B V. D. Anderson Co.

Traps, steam.....Top operating temperature per dollar of fuel consumption. This trap purges all air & non-condensibles from pipes & equipment continuously.
50 *W. H. Nicholson

Traps, Steam.....Booklet, "The Why & How of Steam Trapping" for complete information on impulse type. All operate on a proven thermodynamic principle.
115 Yarnall-Waring Co.

Tubes, Heat Exchanger.....for longer service the tubes have a full range of copper-base alloys for every application. Give complete control of quality.
20-21 *Phelps Dodge Corp.

* From advertisement, this issue

Instruments & Controls

Analyzer, Oxygen.....Analyzes and continuously records minute quantities of oxygen dissolved in feedwater for steam generating plants. Bul. 148.
227A Cambridge Instrument Co.

Boiler-Water Gages.....Condensed 2-page booklet covers in detail the manufacturer's line of high-pressure boiler-water gages. Specifications and illustrations.
227B Jerguson Gage & Valve

Computers, electronic.....Royal precision LGP-30 . . . easy to operate, plugs into any regular wall outlet, compact, completely mobile. Nation-wide sales and service.
1 *Royal McBee Corp.

Controller, Pressure.....Designed for installation where desirable to change outlet pressure & maintain without variation set outlet pressure. Bulletin No. 5000.
227C Norwalk Valve Co.

Data Processing System.....System is capable of receiving up to 1,000 input signals at high speed, converting to digits, and putting information on magnetic tape.
227D Beckman/Systems Div.

Flow Tube.....A lightweight, low-cost, plastic flow tube is the subject of a new bulletin. Includes metallic throat lining, and available in variety of sizes.
227E B-I-F Industries, Inc.

Liquid Level Gages.....Catalog 335 illustrates standard and special function gages and valves; gives dimensions, construction, and pressure and temperature ratings.
227F Jerguson Gage & Valve Co.

Meters, Magnetic Flow.....for complete information on the meter that has no flow restrictions, specify Bulletin 20-14B. Handles all difficult liquids accurately.
135 *Foxboro Co.

Propeller Meters.....Bulletin 314-1 covers the manufacturer's complete line. Emphasis on principles of propeller meters along with performance graphs.
227G Sparling Meter Co.

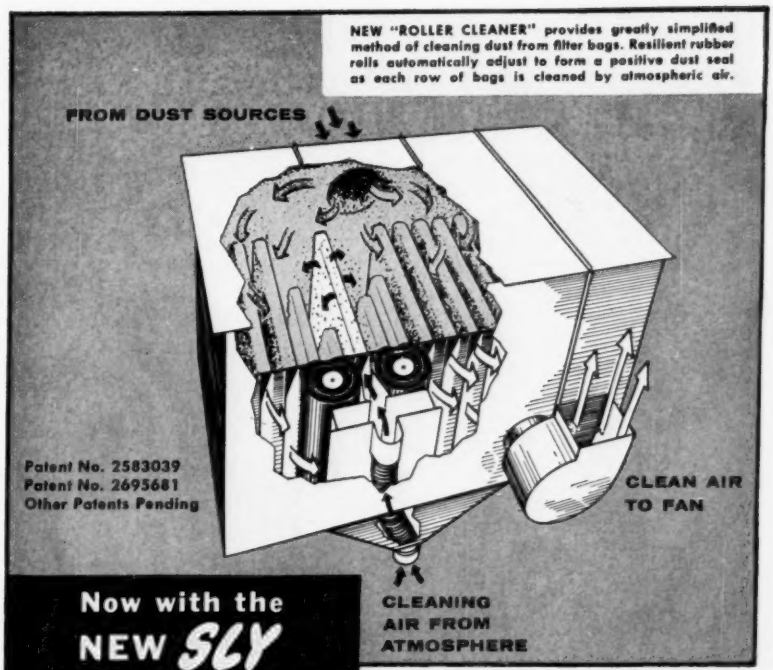
Pyrometers.....designed to give accurate temperature readings under the most severe conditions of dirt, vibrations & corrosive atmosphere. Bulletins 4371 & 4361.
R236 *Illinois Testing Laboratories

Rotameters.....Bulletin 18B describes company's line of rotameters for measuring fluid rate of flow in pipelines 2 in. diameter and larger. Reads directly.
227H Schutte and Koerting Co.

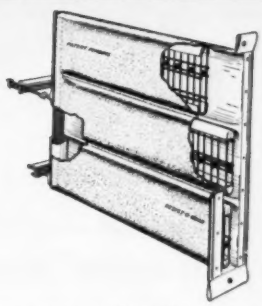
Temperature Controls.....Type E32N features a calibrating mechanism that makes possible easy replacement of the thermal assembly in field with no loss of accuracy.
227I United Electric Controls

Thermocouples.....Engineering data bulletin describes applications, advantages and materials of construction of manufacturer's line of furnace tube wall thermocouples.
227J Thermo Electric Co., Inc.

*From advertisement, this issue


NEW "ROLLER CLEANER" provides greatly simplified method of cleaning dust from filter bags. Resilient rubber rolls automatically adjust to form a positive dust seal as each row of bags is cleaned by atmospheric air.
FROM DUST SOURCES
Patent No. 2583039
Patent No. 2695681
Other Patents Pending
CLEAN AIR TO FAN
CLEANING AIR FROM ATMOSPHERE

Now with the NEW SLY "ROLL-CLEAN" DYNACLONE



As much as 3 TIMES LONGER BAG LIFE

NEW SLY "RESIST-O-WEAR" FILTER BAGS (patent pending) provide complete dust filtration with as much as three times longer life than conventional bags. This has been proved on the toughest field installations.

The new bag has three equal-size sections. Each pocket has two spacers, making a total of six per bag. Weight is distributed on three seams rather than one, minimizing strain. A special protective flap on the back end prevents abrasion from incoming dust.

Now standard in the new "Roll-Clean" Dynaclone, Sly "Resist-O-Wear" bags combine with all the other superior Dynaclone features to assure greatest dust collecting efficiency with unequalled maintenance-free service.

ALL THESE FEATURES IN ONE DUST FILTER

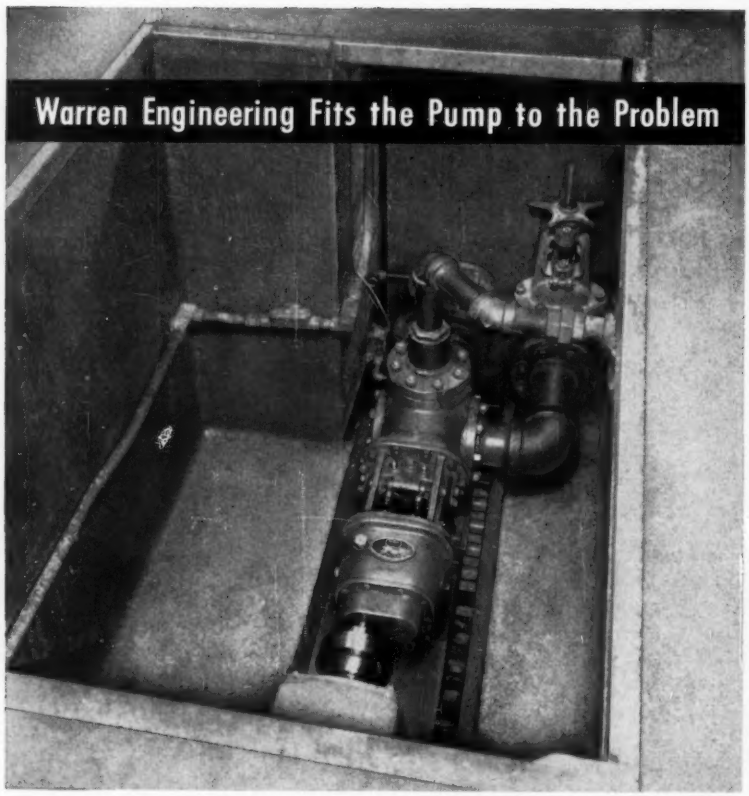
- New "Resist-O-Wear" bags last as much as three times longer.
- Constant suction at dust sources—complete dust collection.
- Automatically self-cleaning for continuous operation.
- Free-rolling cleaner. Complete dust seal—automatic seal adjustment.
- Greater filtering capacity; smaller space requirements.
- Simplified construction for ease of inspection and servicing.

SEND FOR New Bulletin 105 and New 36-page Dust Control Catalog 104.

SINCE 1870 SLY

THE W. W. SLY MANUFACTURING CO.

4771 TRAIN AVENUE • CLEVELAND 1, OHIO
OFFICES IN PRINCIPAL CITIES



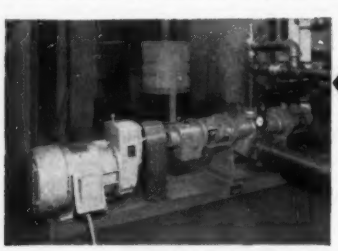
Abrasive quality of insulating paint was death on pumps... until Warren engineers suggested this *special* Warren Screw Pump.

What type of pump will best handle an extremely abrasive and viscous material?

After wearing out one pump in a few *hours*, another in a few weeks... a large manufacturer of electrical equipment sought the help of Warren engineers. The solution was the Warren # 3½ External Gear and Bearing Screw Pump pictured above.

It wasn't delivered "off the shelf," though. Warren engineers suggested several special experience-proven features to prolong the life of the pump against the abrasiveness of the widely-used and highly efficient insulating paint. And it was designed to handle 40 GPM at 60 PSI discharge pressure at 32,000 SSU viscosity at 420 RPM.

Although the pump was installed deep in a pit, over a year ago, maintenance has been no problem — because there has been no need for it. A thorough inspection after 1900 hours' operation showed *no* wear. Warren engineers have again fitted the pump to the problem.



Here is another Warren # 3½ External Gear and Bearing Screw Pump recently installed in the same plant.

For detailed information on Warren External Gear and Bearing Screw Pumps, write for Bulletin S-206.

WARREN PUMPS, INC.
WARREN, MASSACHUSETTS C-9

Pipe, Fittings, Valves

Connectors, aligning.....Fits over stainless pipe and fittings. Permits speedy welding or silver brazing of tight, leakproof, socket-type joints. Speedline catalog gives particulars.
99 *Horace T. Potts Co.

Equipment, Rubber & Plastic.....fittings, valves & linings in high-impact, rubber-plastic. Economical & insensitive to corrosives. Write for information.
192 *American Hard Rubber Co.

Flanges.....A 36-page pocket reference booklet contains useful data on flanges in forged steel or special models in carbon or alloy steel, and on expansion joints.
102 *Phoenix Mfg. Co.

Hose, Flexible Metal.....Hose combines the strength of stainless steel with the right wall thickness for ductility and flexibility. Pressures to 4,000 psi.
228A Allied Metal Hose Co.

Hose, acid.....Chemical resistant, with stainless steel fittings. Flexible, easy to handle, resistant to abrasion, impact and weather. For either suction or discharge service.
189 *United States Rubber

Hose, Flexible.....General Catalog shows full line of standard flexible hose & tubing products. American is equipped to work in copper alloys, stainless steel, etc.
218 *The American Brass Co.

Hose, Stainless Steel.....Folder gives full engineering information & tabular data on pressure capabilities, flexibility, suggested usage & help on specific problems.
228B Allied Metal Hose Company

Hose, Steel Flexible.....A new 4-page engineering folder gives full data on pressure capabilities, flexibility, suggested usage and length formulas.
228C Allied Metal Hose Co.

Joints, Expansion.....New 80-page catalog includes complete information for rating expansion joints, together with tables for calculating forces in connected piping.
228D Badger Mfg. Co.

Joints, Expansion.....Offer lateral or angular motion without flow reduction of conical type liners. New 28-page Expansion Joint Design Guide is available.
223 *Flexonics Corp.

Pipe, Duplex.....Brochure gives details on joining, sizes, alloys & pressure ratings, etc. Lightweight & easy to handle, stands up against corrosion.
133 *Reynolds Metals Co.

Pipe, Pyrex.....keeps out traces of distilled organic impurities that sneak in through absorption. Pipe is strong & cannot corrode. Details in Bulletin PE-3.
226 *Corning Glass Works

Safety Head.....Rupture discs are fully interchangeable in Safety Head flanges, give highly desirable protection when difficult conditions prevail.
209 *Black, Sivalls & Bryson, Inc.

* From advertisement, this issue

(*Continued on p.* 232)

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7	41	62	92D	107-8e	131a	144c	195	205A	212	220A	223B	227	232C	TL238
8-9	42	63	93	107-8f	131b	145	196	205B	212A	220B	223C	227A	232D	BL238
10-11	43	64	94A	109	131c	150	197	206	212B	221	223D	227B	232E	R238
14	44	65	94B	110	131d	151	198	206A	212C	221A	224	227C	233	238A
15	45	66	95	111	131e	152	L199a	207	212D	221B	224A	227D	233A	238B
16-17	46	68	96A	112	132	154	L199b	207A	212E	221C	224B	227E	233B	238C
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24-25	50	77	100	116	136	183	200	208B	R213	222B	225	227I	234A	TL244
26-27	51	79	101	117	137	185	201a	209	214	222C	225A	227J	234B	BL244
28-29	52	81	102	118	138	187	201b	209A	215	222D	225B	228	234C	R244
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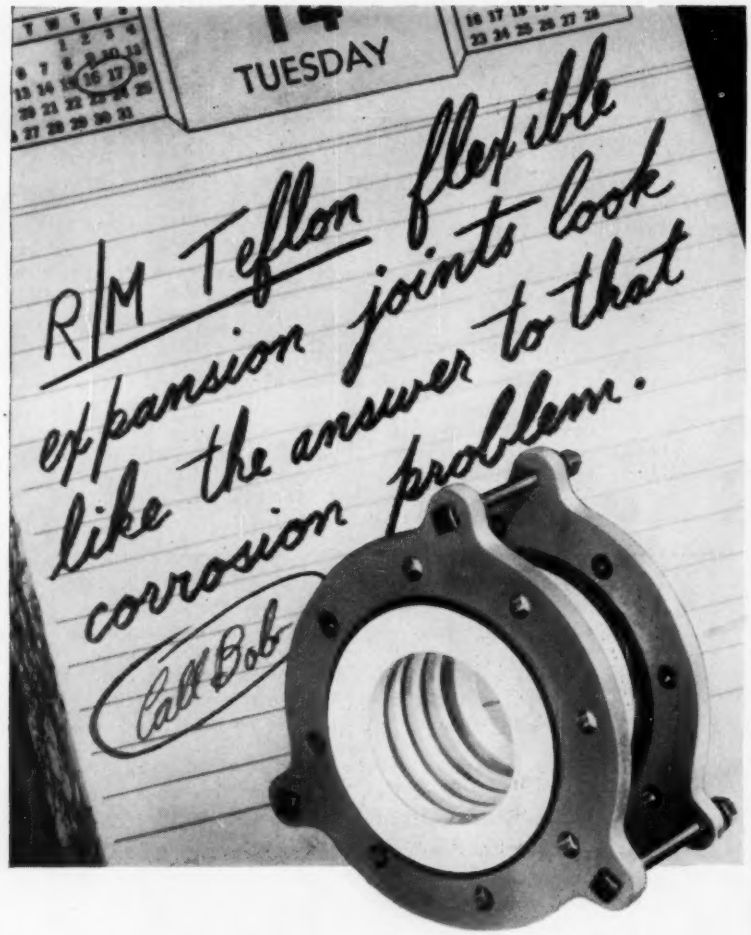

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LITERATURE . . .

Tubing, Flexible.....for any operating conditions, bronze, galvanized & stainless steel corrugated & interlocked tubing.
R211 *Pennsylvania Flexible Tubing Co.

Valve.....New 4" size valve . . . available in Durco type F valves series. Has renewable Teflon sleeve. Nonlubricated, non-sticking also available in variety of alloys.
187 *The Duriron Co., Inc.

Valve, Chlorine.....The No. 1644 forged steel glove valve is designed especially for chlorine gas or liquid service. Information on this & other valves available.
151 *Crane Co.

Valves.....DeZurik has valves for all types of services. They need no lubrication . . . don't leak . . . and withstand the toughest corrosion problems.
40 *DeZurik Corp.

Valves.....come in fifteen sizes, designed to meet over 300 variations in installation requirements. Valve units used to re-valve older pumps. Booklet CE-98.
206 *Durabla Mfg. Co.

Valves.....All kinds & types available in a variety of Nickel & Monel. Able to handle every flow requirement. Information on all models is available.
95 *The Wm. Powell Co.

Valves, Ball.....Double-Seal ball valves handle a wider range of liquids and gases. They take care of acids, abrasives, chemicals, solvents, etc. Literature.
207 *Jamesbury Corp.

Valves, Explosive.....New, 16-page catalog describes and illustrates complete standard line and typical specials of manufacturer's line of explosive-type valves.
232A..... Conax Corp.

Valve, Flush.....A new one-piece bottom outlet flush valve features a glassed head and stem, with glass-filled Teflon seat to provide corrosion protection.
232B Pfaudler Co.

Valves, Forged Steel.....New 92-page catalog describes the manufacturer's complete line of standard valves. Includes ASA dimensions and ratings.
232C Rockwell Mfg. Co.

Valves, plug.....stop slurry valve failure. Lubricated plug valves eliminate packing problem. Cavity-free flow passages & seating surfaces never exposed to the line.
55 *Rockwell Manufacturing Co.

Valve, Relief.....For hot water space heating boilers. Bulletin contains diagrams and basic facts on the selection and installation of relief valves.
232D McDonnell & Miller, Inc.

Valves, solenoid.....Complete selection of solenoid valves capable of controlling corrosive gases and liquids. Fluids handle range from sulfuric acid to sodium hydroxide.
79 **Automatic Switch Company

Valves, Solenoid.....Bulletin 500 C includes pictures and description of basic types of solenoid valves, covering a wide range of operating conditions.
232E J. D. Gould Co.

* From advertisement, this issue

Process Equipment

Agitators, Tank Top.....Model WT is available in 7 sizes with a complete range of speeds. Feature helical gear trains & worm gears. Bulletin 551 and data sheet.
210 *New England Tank & Tower Co.

Centrifuges.....Bulletin covers three types of automatic centrifuges: for liquid clarification, for three-phase separation, and for continuous concentration.
233A Centrico, Inc.

Centrifuges.....Greater capacity for solids dewatering. If a solids dewatering step is necessary in your processing, it will pay you to get the facts. Write today.
28-29 *Sharples Corporation

Collectors, dust.....Higher efficiency, longer service life, lower operating cost are features of these collectors. Available in single and multiple units.
91 *The Ducon Co., Inc.

Condensers, Barometric.....Bulletin 5AA describes manufacturer's line of barometric condensers for removing air, steam and other vapors from vacuum equipment.
233B Schutte and Koerting Co.

Dissolvers.....for ultimate dispersions, dissolving, emulsifying & deagglomerating in processing solid-liquid, liquid-liquid & gas-liquid materials. Information in catalog.
129 *Morehouse-Cowles

Dryers, Spray.....Portable, utility, pilot & industrial types are described & illustrated in a new brochure. Engineering services offered are included. Bul. 237.
233C *Nichols Engineering & Research

Drying system.....Raymond's flash-drying system is effective with chemicals, foods, filter press products, synthetic resins and many more. Bulletins for information.
152 *Combustion Engineering Inc.

Dust Collection Systems.....Booklet, "The Collection & Recovery of Industrial Dusts," gives information on Cyclone, "SF" Electric Precipitator & Precipitator-Cyclone.
234 *Buell Engineering Co.

Equipment, Ion Exchange.....for removal of mineral impurities from solvent solutions, chemical intermediates etc. General information in Bul. 200.
114 *Industrial Filter & Pump Mfg. Co.

Filter, Density.....for use with the AO R-2090 Respirator. New "Air Floatation" process forms the medium. All fibers bonded together by special fusion process.
89 *American Optical Co.

Filter Fabrics.....all types of wet or dry filtration equipment. Technical assistance in selecting proper fiber & fabric construction for requirements. Bul. KSF-1.
233D Komline Sanderson Corp.

Filter Media, Metal.....can withstand temperatures from 420° to 1200° F. & pressures from a nearly perfect vacuum to 6,000 psi. Brochures outline what they can do.
120 *Purolator Products, Inc.

* From advertisement, this issue

DURALOY

25-20 Casting with Welded Assembly

This is a separator destined for a reaction process. It is typical of the kind of work we do in the high alloy casting field. In the 25 Cr-20 Ni range it is alloyed to withstand both corrosion and heat. Assembled, its weight runs some 2000 pounds. It was inspected and tested under very rigid ASME Code requirements.

The production of chrome iron and chrome nickel castings has been our sole business since 1922. We added centrifugal castings to our service in 1933 and shell molded castings in 1955. Our metallurgists have extensive knowledge of the many operations requiring high temperature and corrosion resistant castings. Perhaps this experience would be helpful to you if you are confronted with a specific problem and wish to determine the best alloying combination for your required castings. We can be helpful, too, in designing the unit, contributing our knowledge of strength and stresses in castings.

The DURALOY Company
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ATLANTA OFFICE: 76—4th Street, N.W.
CHICAGO OFFICE: 332 South Michigan Avenue
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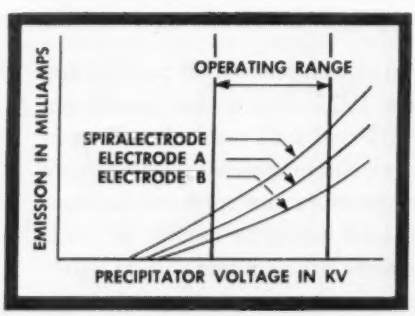
1500 miles of Spiralectrodes in Precipitator Service!

That's real proof of superior performance. Over 1500 miles of these emitting electrodes have been installed in 'SF' electric precipitators . . . delivering 50 to 100% more electron emission than conventional types of electrodes.

There are sound reasons why Buell *Spiralectrodes* are providing superior emitting efficiency in actual dust collecting applications.

- *Spiralectrodes* are *"emission engineered"* – pitch and diameter are custom designed for each application . . . of critical importance with high resistivity dust.
- *Spiralectrodes are precision made from stainless steel*– of uniform quality, corrosion-resistant.
- *Spiralectrodes minimize efficiency-loss of dust build-up* –no horizontal surface to collect dust, positive rapping cleans electrodes.
- *Spiralectrodes maintain predetermined tension* – (no weights required) . . . dampen effect of vibration caused by electrical pulsation, thereby minimizing electrode breakage.
- *Spiralectrodes'* controlled area emission stops sparking effect of "point emission."



Above chart illustrates the superior emission of the Spiralectrode: its corona voltage is lower and its emission is higher than other types of emitting electrodes over the entire operating range of industrial precipitator voltage.

The superior operating characteristics of Spiralectrodes contribute to continued high efficiency of Buell 'SF' Precipitators. Detailed information of this and other exclusive features are described in a booklet, "Buell 'SF' Electric Precipitators." Send for your copy: write Dept. 12-I, Buell Engineering Company, Inc., 123 William Street, New York 38, New York.

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Experts at delivering Extra Efficiency in

DUST COLLECTION SYSTEMS

LITERATURE . . .

Filter Presses.....Company's filter presses are available in designs and capacities to handle any filterable mixture and any filter material. Catalog.
225 *D. R. Sperry & Co.

Filter, vacuum.....Six times the capacity per foot of filter area as the ordinary, multi-cell, drum filter. Different design and construction. New concept of vacuum filtration.
4 *Bird Machine Co.

Filters.....Illustrated Bulletin GEO-506 gives applications on all Fulflo model filters. Exclusive honeycomb filter tubes provide true depth filtration.
234A Commercial Filters Corp.

Filters, Dust.....The new bag has 3 equal size sections. Each pocket has two spacers, making a total of six per bag. Other details in Bul. 105 & Dust Control Catalog.
227 *The W. W. Sly Mfg. Co.

Filters, Oil.....a complete new line with advanced engineering features that give you quick opening covers, low pressure drop, & extra high flow rates. Bul. 101.
234B Commercial Filters Corp.

Filters, Pressure Leaf.....Bulletin presents information on line of leaf filters and their applications. Illustrations and tables provide specifications.
234C T. Shriver & Co.

Lubricator, portable.....Saves 95 man-hours for every drum of lubricant applied. Compact and portable —brings clean, waste-free lubrication to any machine in your plant.
57 *Stewart-Warner Corp.

Mills, reversible hammer.....Hammers can be operated in both directions by reversing switch on driving motor. Maintenance and down time are cut 50% or more.
59 *Williams Patent Crusher & Pulverizer

Pulverizer & Classifier.....for grinding & classifying in one operation. Air attrition impact with controlled radial inward classification. Request free color bulletin.
97 *Strong-Scott Mfg. Co.

Rotary Mixer-Blender.....Mixes materials of varying specific gravities and minute or trace quantities. Available with internal spray pipe for liquid addition.
234D Munson Mill Machinery

Turbo-Mixer.....Detailed information and useful design data contained in the various bulletins which are offered. Useful in processing of different metals & ores.
134 *General Amer. Trans. Corp.

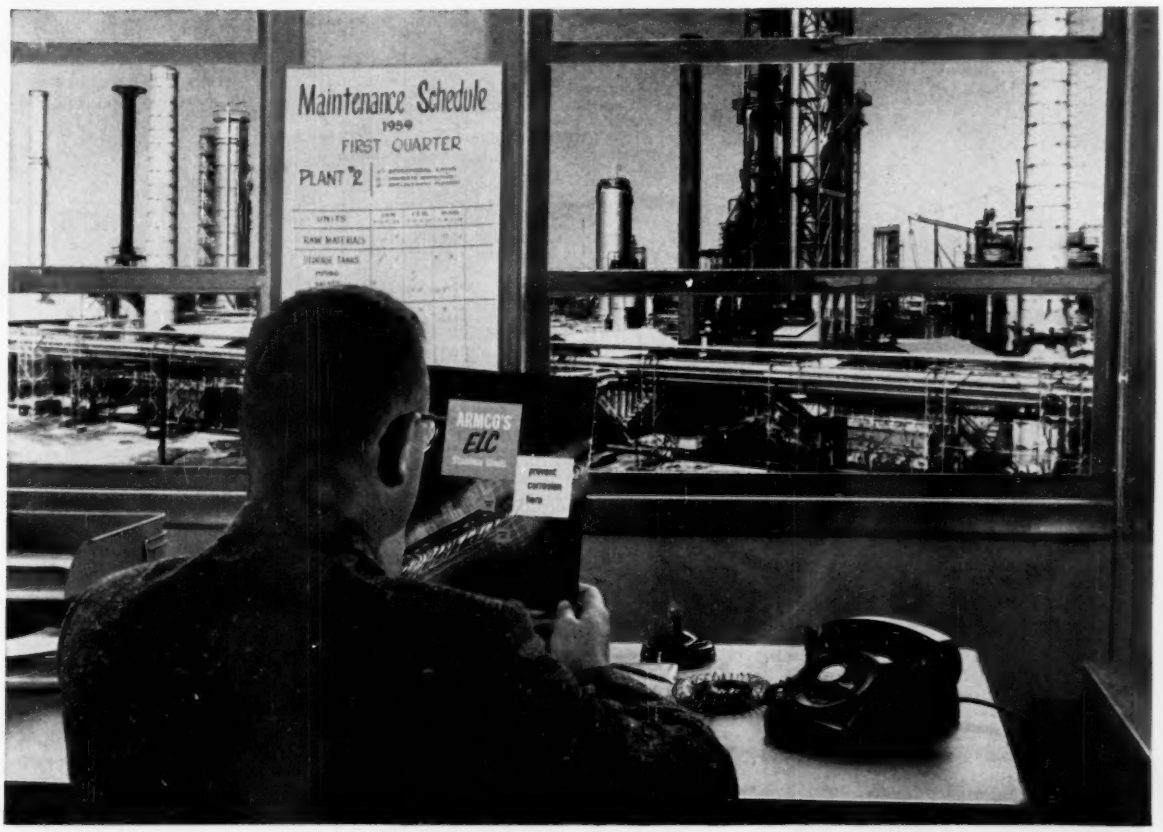
Vibrating Screens.....Booklet contains complete data and specs on manufacturer's line of grizzly bar screens, vibrating screens and feeders.
234E Syntron Co.

Pumps, Blowers, Compressors

Blowers, Rotary Positive.....New compact design features a vertical arrangement of the impellers to provide horizontal inlet and discharge connections.
234F Roots-Connersville

* From advertisement, this issue

PLAN AHEAD with your Armco Stainless Steel Distributor to cut down-time and maintenance costs



Shut-down emergencies and routing maintenance can't be avoided. But you *can* reduce costly down-time and maintenance expense by planning ahead with your Armco Stainless Steel Distributor.

If he knows your requirements and you are familiar with his services and complete stocks of Armco Stainless Steels, you can save valuable time when repairs or alterations must be made *right now*. For example, he can shear, cut or saw stainless steels to your exact specifications.

In routine maintenance, too, your Armco Distributor's Stainless Steel Service Center can save you money. As close as your telephone, you have a complete inventory of standard and special Armco Stainless Steels. And the services of mill-trained engineers are available for assistance in grade selection and fabrication.

Make the most of the cost-cutting advantages that your Armco Stainless Steel Distributor offers you. Get in touch with him today. If you don't know his address, just fill out and mail the coupon.

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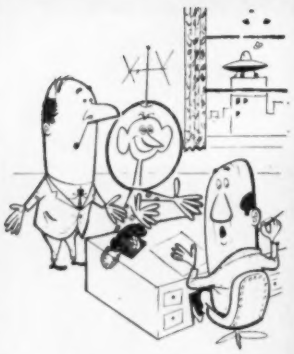

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LITERATURE . . .

Compressor.....The most simple compressor means low maintenance cost, with original pump performance constant over long periods. No internal wearing parts.
56 *Nash Engineering Co.

Compressor, centrifugal.....The best way to seal oxygen and hydrocarbon gases? Carrier's centrifugal compressors are designed with the right seal for the specific job.
52 *Carrier Corp.

Compressor, High Pressure.....Frames with double row roller bearings, & reversible ring plate valves are special features. Catalog gives information on all compressors.
220 *Norwalk Company, Inc.

Compressors.....available from 200 to 6000 horsepower. Handle compression of various gases in the petrochemical industry. Detailed information is available.
110 *Cooper Bessemer

Compressors.....for pressure & vacuum, for air, gases & vapors. Operate at higher motor speeds. No bulky air receivers required, no danger of contamination.
105 *Ingersoll-Rand

Compressors, Rotary.....There are twelve sizes of two-stage Ro-Flo compressors to choose from. For information see bulletins 16B8244 and 16B8126.
145 *Allis-Chalmers

Pump.....For information about the complete line of pumps, bulletins are available. The Type GB single stage, end suction centrifugal pumps handle all jobs.
194 *Weinman Pump Mfg. Co.

Pump, centrifugal.....For pumping chemicals, use the LaBour centrifugal pumps. Open impellers with generous clearances lick the solid-particles problem.
48 *LaBour Company

Pump, Chemical.....to end your liquid metering problems. Write for Bul. 440 with typical applications, flow charts, description specification of models available.
127 *Lapp Insulator Co.

Pump Packings.....Extremely effective for rotating & reciprocating shafts. Supplied in sets to meet specific requirements. Complete information in Bulletin AD-155.
200 *United States Gasket Co.

Pumps, Screw.....Abrasive quality of insulating paints is overcome by this new model. Completely resistant. For details on external screw pumps, send for Bulletin S-206.
228 *Warren Pumps, Inc.

Pumps.....decreased down-time to a minimum . . . maintenance costs reduced substantially. Full information available as to installation & maintenance.
108 *Aldrich Pump Co.

Pumps, Acid.....Available with pumping parts of the machinable alloys as well as plastic to meet all requirements. Request complete details.
137 *A. R. Wilfley & Sons, Inc.

Pumps, Centrifugal.....In every detail of size, weight, space requirements & power. Bulletin 110F contains engineering data, performance charts & diagrams.
87 Eastern Industries, Inc.

* From advertisement, this issue

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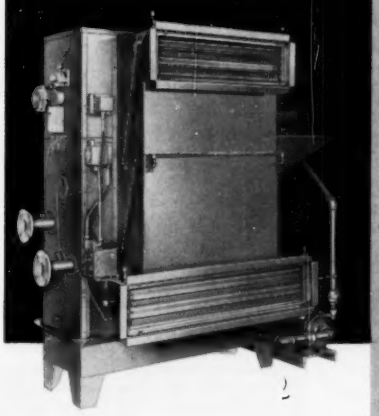

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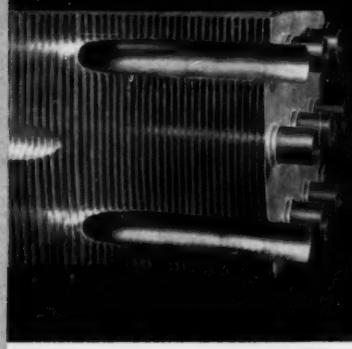

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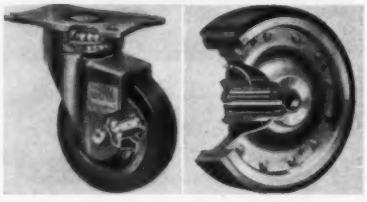

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36 NORTH CLINTON STREET, CHICAGO 6, ILLINOIS

LITERATURE . . .

Pumps, Ni-Resist.....For answers to your corrosion problems, get the details in booklet "Engineering Properties & Applications of Ni-Resist".
112 *The International Nickel Co.

Pumps, Rotary Blowers.....Full details on continuous-service rotary positive pressure blowers, gas and vacuum pumps are discussed in new company bulletin.
238A Sutorbilt Corp.

Pumps, Vertical Process.....A new way to pump corrosives, especially built to handle heavy duty. Complete outline of features in Bulletin No. 727-1.
132 *Goulds Pumps, Inc.

Services, Processes, Misc.

Bench-Scale Equipment.....a complete integrated line of professionally designed equipment for pressures up to 5000 p.s.i. Detailed information in Bulletin 658.
14 *Autoclave Engineers, Inc.

Biological Tests.....16 p. "Biology & Business" covers toxicity testing, microbiology, odors and vapors, physiological and related testing for drug & cosmetics makers.
238B Foster D. Snell, Inc.

Engineering services.....Dorr-Oliver's world-wide engineering services cover all phases of fertilizer plant design. Booklet No. 8000 gives full details.
70-71 Dorr-Oliver, Inc.

Industrial Tools.....A complete 156-page hand tool buying guide is offered. It also includes a complete range of automotive tools & shop equipment for truck fleets.
221 *Snap-On Tools Corp.

Laboratory Equipment.....4 p. bulletin on the new time saving Automatic flash point tester, duplicating ASTM D56 results and needing no attendance during test.
238C Precision Scientific Co.

Laboratory Equipment.....2 p. bulletin on the new time saving Autoeter with a 0 to 1,000 mv. range. Accurate to plus or minus 1 mv. and 0.02 ph.
238D Precision Scientific Co.

Leak Detectors.....Bulletin describes in text tables and pictures, the characteristics and applications of detectors for locating leaks in pressure or vacuum systems.
238E General Electric

Plant, pilot.....Pilot plants speed your product development work in many ways. Smaller plants for testing and sampling; larger plants for small production runs.
68 *Patterson-Kelley

Process Development.....26 p. brochure describes services of company which designs & builds chemical plants, creates & develops chemical processes.
238F Scientific Design Co.

Welding.....Methods and specific information are outlined in the illustrated Weldment Bulletin 7001. The welding of pressure vessels is one of the many jobs detailed.
38 *Baldwin-Lima-Hamilton

* From advertisement, this issue

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1—Aluminum evaporator, Calandria type, never used, 1300 sq. ft. tube area.
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4—Ruggles-Coles Class #XA-18 double shell indirect-direct heat rotary dryers, 104″ x 70′ x ⅜″ welded steel outer shell.
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3 A. O. Smith Stainless Lined Pressure Tanks; 10' x 18'7"; 11,000 gal. like new

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NEW Falcon Stainless Reactor; 125 Gal. 30" x 30"; Jacketed; Agitated; Motorized

A. T. & M. Stainless 60" Centrifugal Extractors; link suspended; center slung; vapor-tite hoods

Tolhurst 40" Center Slung, Rubber Covered Basket & Curb; Monel Plow; 2 Speed

Sharples Stainless Super-D-Canter; 10 HP

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Stainless Steel Heat Exchangers 65 to 4000 sq. ft.

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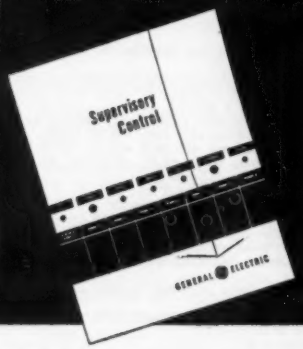

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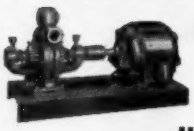

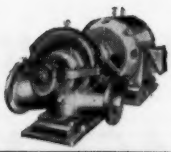

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INDEX OF ADVERTISERS

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Aldrich Pump Co. 118
Alemite, Div. of Stewart Warner Corp. 57
Allen Bradley Co. 113
Allis-Chalmers Mfg. Co. General Machinery Div. ..... 39, 145 Industrial Truck Div. 109
Aluminum Co. of America Petro-Chemicals Div. 141-144
American Air Filter Co. 65
American Brass Co. Metal Hose Div. 218
American Cyanamid Co. 12-13
American Flange & Mfg. Co. 181
American Hard Rubber Co. 192, 193
American Optical Co. 89
Amercoat Corp. 183
Appleton Electric Co. 63
Armco Steel Corp. 235
Atlas Mineral Products Co. 215
Aurora Pump Div., The N. Y. Air Brake Co. 244
Automatic Switch Co. 79
Autoclave Engineers 14
Bailey Meter Company 211
Baldwin-Lima-Hamilton Corp. Eddystone Div. 38
Barneby-Cheney Company 203
Bird Machine Co. 4
Black, Sivalls & Bryson Safety Head Div. 209
Blaw-Knox Co. Equipment Div. 60
Boardman Company 219
Bridgeport Brass Co. 150
Buell Engineering Co. 234
Buffalo Forge Co. 49
Cambridge Wire Cloth Co. 212
Carrier Corp. 52
Cole Mfg. Co., R. D. 213
Combustion Engineering, Inc. Raymond Div. 152
Continental Can Co. 101
Cooper Bessemer Corp. 110
Coppus Engineering Co. 37
Corning Glass Works 226
Crane Company 151
Crane Packing Co. 205
Curtiss-Wright Corp. Metals Processing Div. 117
Damascus Tube Co. 138
Darnell Corp. 238
Dean Products, Inc. Dean Thermo-Panel Coil Div. 238
De Laval Steam Turbine Corp. 43
Devine Mfg. Co., J. P. 131
De Zurik Corp. 40
Dodge Mfg. Co. 190, 191
Dorr-Oliver, Inc. 70-71
Dracco Corp., Div of The Fuller Company 128
Ducon Company 91
Durabla Mfg. Co. 206
Duraloy Company 233
Duriron Company, Inc., The 187
Eastern Industries, Inc. 87
Eddystone Div., of Baldwin-Lima-Hamilton Corp. 38
Electric Controller & Mfg. Co., Div. of Square D Company 53
Elliott Company 26-27
Esso Standard Oil Co. 81
Ever-Tite Coupling Co. 238
Falk Corp. 35
Fansteel Metallurgical Corp. 204
Flexonics Corp. 223
Flowline Corp. 6
Foster Wheeler Corp. 77
Foxboro Corp. 135
General American Transportation Corp., Turbo-Mixer Div. 134
General Chemical Div., Allied Chemical Corp. 73
General Electric Co. 22-23, 244
Gianni Plasmadyne Corp. 195
Girdler Co., Div. of Chematron Corp. ...Second Cover
Glascote Products, Inc. 16-17
Goulds Pumps, Inc. 132
Great Lakes Carbon Co. Electrode Div. 136
Gustin-Bacon Mfg. Co. 196, 197
Harris & Co., Arthur 246
Haynes Stellite Co., Div. of Union Carbide Corp. 185
Hercules Powder Co. 36
Hough Co., Frank G. 8-9
Hunt Machine Co., Rodney 198
Illinois Testing Laboratories, Inc. 236
Industrial Filter & Pump Mfg. Co. 114
Industrial Nucleonics Corp. 111
Ingersoll-Rand Co. 105
International Minerals & Chemicals Corp. 83
International Nickel Co. 95
International Salt Co. 54
Jamesbury Corp. 207
Jeffrey Mfg. Co. 100
Jenkins Bros. 104
Jones & Laughlin Steel Corp. 106
Kennedy Van Saun Mfg. & Engrg. Co. 213
LaBour Co., Inc., The 48
Lapp Insulator Co. (Pulsafeeder) 127
Leeds & Northrup Co. 46
Link-Belt Co. 15
Liquid Carbonic, Div. of General Dynamics Corp. 125
Mack Iron Works Co. 197
Mallinckrodt Chemical Works 199, 236
Mallory-Sharon Metals Corp. 58
Manning, Maxwell & Moore, Inc. 44, 64
Manton-Gaulin Mfg. Co. 246
Marlo Coil Co. 237
Metal & Thermit Corp. 42
Mine Safety Appliances Co. 139
Morehouse-Cowles Co. 129
Mueller Brass Co. 244
Multi-Metal Wire Cloth Co. 217
Murray Mfg. Co., D. J. 62
Nash Engineering Co. 56
National Carbon Co. Div. of Union Carbide Corp. 85
National Filter Media Corp. 208
New England Tank & Tower Co. 210
Niagara Blower Co. 213
Nicholson & Co., W. H. 50
Norton Co. 61
Norwalk Co. 220
O-T-M Corp. 119
Patterson Foundry & Machinery Co. 103
Patterson-Kelley Co., Inc. 68
Pennsylvania Flexible Metallic Tubing Co. 201

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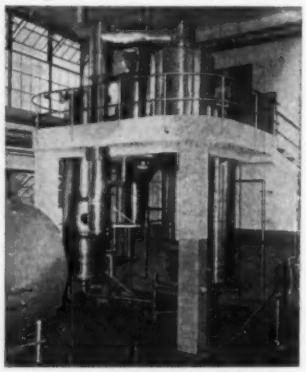

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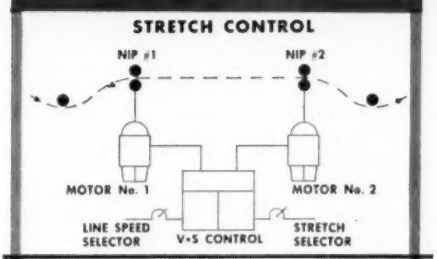
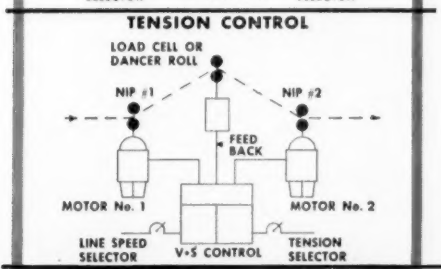
ADVERTISERS . . .

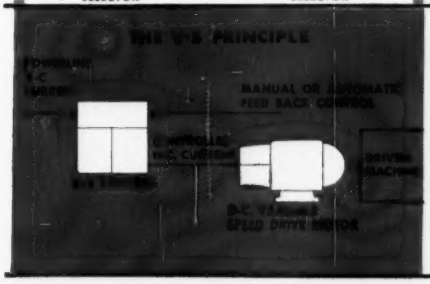
Permutit Co., Div. of Pfaudler-Permutit, Inc. 140
Pfaudler Co., Div. of Pfaudler-Permutit, Inc. .24-25, Fourth Cover
Phelps Dodge Copper Products Corp. 20-21
Philadelphia Gear Corp. 47
Phoenix Mfg. Co. 102
Pittsburgh Coke & Chemical Corp. 51
Powell Valves, Wm. Powell Co. ... 95
Purolator Products, Inc. 120
Raybestos-Manhattan, Inc., Packing Div. 232
Reliance Electric Corp. . . Third Cover
Reynolds Metals Co. 133
Richardson Scale Co. 216
Robbins & Myers, Inc. 45
Rockwell Mfg. Co., Nordstrom Valve Div. 55
Royal McBee Corp. 1
Ryerson & Sons, Inc., Joseph T.. 154
Selas Corp. of America 130
Sharples Corp. 28-29
Shell Oil Company 75
S. Morgan Smith Corp. 22
Sly Mfg. Co., W. W. 227
Snap-On Tools Corp. 221
Solvay-Process Div. Allied Chemical Corp. 93
Speedline Stainless Steel Fittings Div. of Horace T. Potts Co. 99
Sperry & Co., D. R. 225
Sturtevant Mill Co. 199
Strong-Scott Mfg. Co. 97
Superior Separator Co. 201
Texas Gulf Sulphur Co. 41
Thermal Research & Engrg. Corp. 202
Thermo Electric Co. 201
Trane Co. 18-19
Traylor Engineering & Mfg. Co.. 7
Union Carbide Chemicals Co. ... 179
U. S. Gasket Co., Plastics Div. of Garlock Packing Co. 200
U. S. Industrial Chemicals Co. Div. of National Distillers & Chemical Corp. 107-108
U. S. Rubber Co. 189
U. S. Steel Corp., U. S. Stainless Steel Div. 32
U. S. Stoneware Co., The 66
Vilter Mfg. Co. 224
Vogt Machine Co., Henry 177
Vulcan Manufacturing 10-11
Wagner Electric Corp. 30-31
Warren Pumps, Inc. 228
Weinman Pump & Mfg. Co. 194
Westinghouse Electric Corp. ...30-31
Wiegand Co., Edwin L. 214-215
Wilfley & Sons, A. R. 137
Williams Patent Crusher & Pulverizer Co. 59
Worthington Corp. 121-124
Wyandotte Chemical Corp., Michigan Alkali Div. 33-34
Yarnall-Waring Co. 115
Yuba Consolidated Industries... 116

PROFESSIONAL SERVICES 245
CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.
EMPLOYMENT OPPORTUNITIES 239
EQUIPMENT (Used or Surplus New) For Sale 239
ADVERTISERS INDEX
Aaron Equipment Co. 240
Aaron Equipment Co., Div. of Areco Inc. 241
American Air Compressor Corp. ... 241
American Maize Products Company 242
Best Equipment Company 241
Brill Equipment Company 241
Equipment Clearing House Inc. ... 240
First Machinery Corp. 240
Foster Company, L. B. 239
Gelb & Sons, R. 243
Hackett Tank Company 241
Heat & Power Company, Inc. . 239-240
Lawler Company 239
Loeb Equipment Supply Company 241
Machinery & Equipment Corp., N. J. 240
Machinery & Equipment Co., Inc., Calif. 239-241-242
Perry Equipment Corporation . . 239-242
Stein Equipment Corp. 241
Sussman Inc., Louis 239
Union Standard Equipment Company 240

How to Control Tension and Stretch on Web Processes







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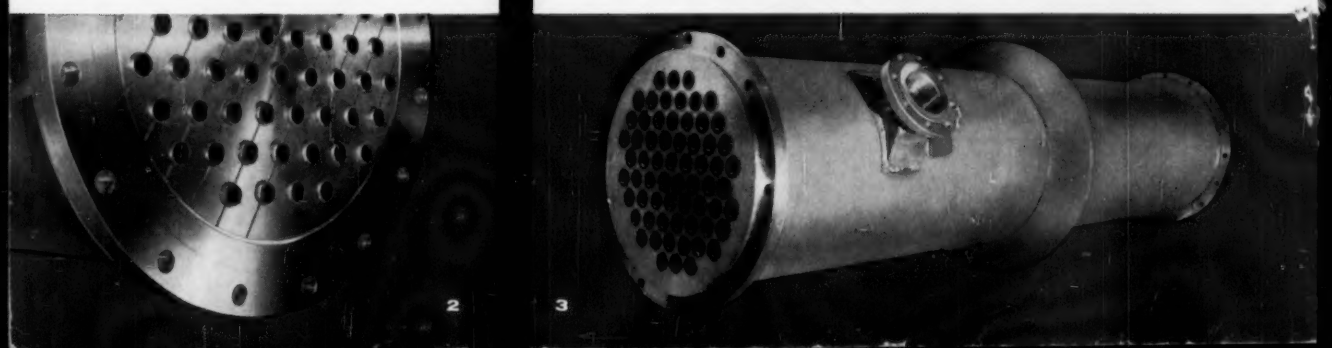
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